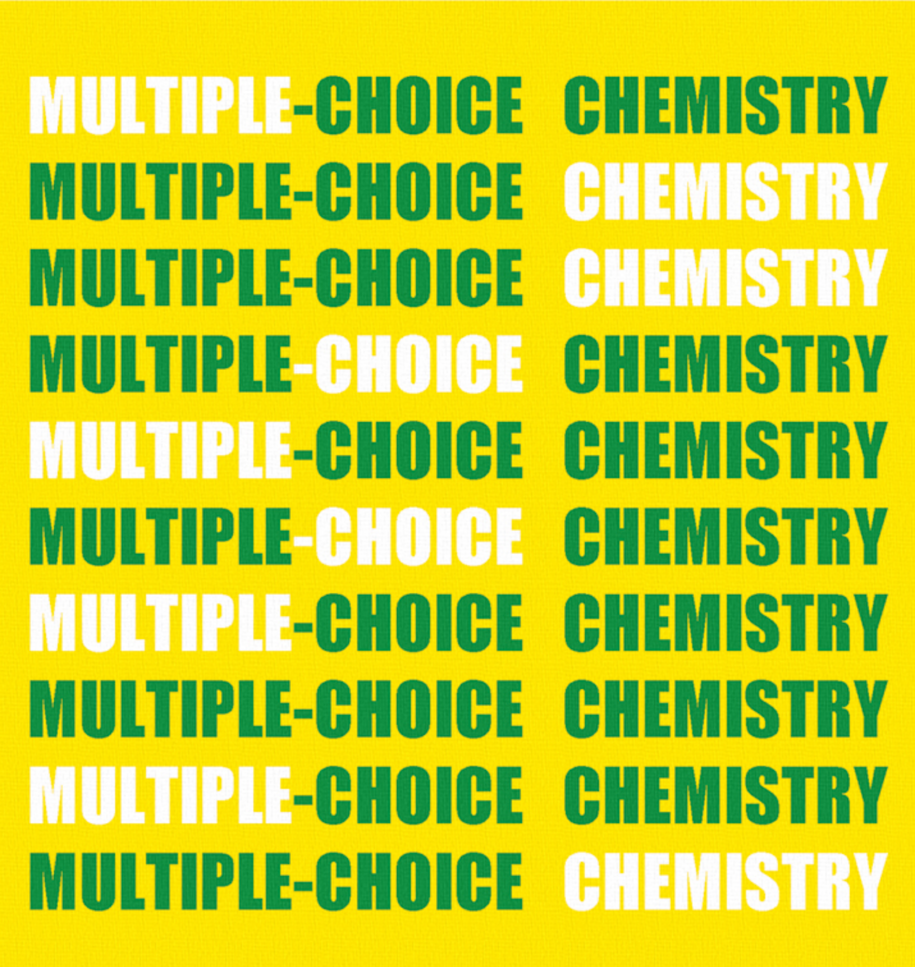
MULTIPLE-CHOICE CHEMISTRY

J.A.S REES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MULTIPLE-CHOICE CHEMISTRY

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NOTE

A list of answers to questions is obtainable from the publishers, and will be sent free to teachers on receipt of a large stamped addressed envelope.

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PREFACE

This work is up to date in that some of the topics are just now being introduced into schools and therefore some sections—e.g., 8, 9, and 10—are ahead of work now being taught but are highly relevant to future development, as indicated by the Nuffield Foundation and referred to in their books.

For sections 19 and 20 the mass of 1 gram-atom of copper is to be taken as 64 and when these sections are used in class all necessary atomic masses should be available.

The reference texts used for these questions were: the *Nuffield 'O' Level Booklets*, *Nuffield 'A' Level Notes;* and standard texts: Heys, *Physical Chemistry;* Goddard and Hutton, *'O' Level Chemistry;* Moody, *Comparative Inorganic Chemistry;* Waddington, *Organic Chemistry;* Liptrot and Pode, *Exploring Chemistry;* Stokes, *Elementary Practical Chemistry;* Inns and Marsden, *'O' Level Practical Chemistry;* Johnstone and Morrison, *Chemistry Takes Shape;* Vogel, *Macro and Semi-micro Inorganic Analysis; Nuffield Background Books; Petrochemical Industry Booklets for Schools.*

January, 1973 J. A. S. R.

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INTRODUCTION

The questions are meant to test the usual range of abilities from knowledge to analysis and the questions have varying degrees of hardness in each set so that it is unlikely that an average examination candidate will attain more than seventy per cent of the marks on any set. There are four basic types of question in this booklet:

1 Five-choice completion

These are items which are followed by five responses and the pupil must select the response which is thought to be correct.

For example:
The blue compound formed when copper(II) oxide is added to dilute nitric acid is

A copper(II) hydroxide
B copper(II) nitrate
C nitrogen oxide
D hydrated copper(II) oxide
E an aqueous solution of nitrogen dioxide

The correct response is **B**.

2 Multiple selection

These items consist of a stem followed by three statements and the pupil must select the items which correctly refer to the stem. The keys are:

Response	**Correct statements**
A	**1, 2, 3**
B	**1, 2**
C	**2, 3**
D	**1**
E	**3**

For example:
Why is lead carbonate more easily decomposed by heat than magnesium carbonate?

1 lead is heavier than magnesium
2 all carbonates are decomposed by heat
3 lead is lower in the Activity Series than magnesium

The correct response is **E** because **3** only is correct.

Assertion-reason

Each item consists of an assertion and a reason, and the pupil has to decide upon the correctness of each within the limits of the key, which is as follows:

Response	**Assertion**	**Reason**	**Explanation**
A	true	true	reason is a correct explanation of assertion
B	true	true	reason is *not* a correct explanation of assertion
C	true	false	
D	false	true	
E	false	false	

For example:

ASSERTION		**REASON**
Polyethylene is a plastic	because	it is made from an unsaturated hydrocarbon.

The correct response is **B** because both assertion and reason are true but the assertion is not a correct explanation of the reason.

4 Classification

Five responses are presented to the pupil and several items follow the lettered responses; the pupil must select the response thought to be correct for a particular item. Each response may be used once, more than once or not at all.

For example:

Questions 1 to 5 refer to the list of elements and compounds given below. Select the response which you think is correct.

A copper
B lithium
C ethanol
D starch
E duralumin

1 Which will give coloured ions in aqueous solution? Key **A**

2 Which is the heaviest metal? Key **A**

3 Which is a macromolecule? Key **D**

4 Which is an alloy? Key **E**

5 Which will yield hydrogen on the addition of sodium? Key **C**

The above is a simple example in which response **B** has not been used.

A summary of these instructions is included on a fold-out page at the back of the book, for use when answering questions.

NITRATES

1 Which of the following nitrates melt, effervesce and evolve dinitrogen oxide and water when heated?

A copper **B** silver **C** magnesium
D ammonium **E** sodium

2 All of the following lead(II) salts are obtained by mixing a solution of lead(II) nitrate and a solution containing the required anion *except:*

A acetate **B** chloride **C** chromate
D iodide **E** sulphate

3 Which of the following gases is evolved when the nitrate of a metal in Group 2 of the Periodic Table (e.g., copper) is strongly heated?

A hydrogen **B** nitrogen
C oxygen **D** nitrogen oxide
E ammonia

4 How many cubic decimetres of oxygen would be obtained at STP when 1 mole of lead(II) nitrate is thermally decomposed?

A 89·6 **B** 44·8 **C** 22·4
D 11·2 **E** 5·6

5 Which of the following nitrates will leave no solid residue after strong heating?

A potassium **B** aluminium **C** calcium
D zinc **E** mercury

6 Which of the following gases is neutral to moist litmus?

A ammonia **B** nitrogen dioxide
C oxygen **D** carbon dioxide
E chlorine

7 How many cm^3 of 0·1 M sodium hydroxide will neutralize 25 cm^3 of 0·5 M nitric acid?

A 5 **B** 10 **C** 25
D 62·5 **E** 125

8 Which of the following reactions does *not* take place?

A $CuO(c) + 2H^+(aq) \rightarrow Cu^{++}(aq) + H_2O(l)$
B $Mg(OH)_2(c) + 2H(aq)^+ \rightarrow Mg^{++}(aq) + 2H_2O(l)$
C $2Zn^+(c) + 2H^+(aq) \rightarrow 2Zn^{++}(aq) + H_2(g)$
D $NH_3(g) + HNO_3(aq) \rightarrow NH_4^+(aq) + NO_3^-(aq)$
E $4HNO_3(l) \rightarrow 2H_2O(l) + 4NO_2(g) + O_2(g)$

	ASSERTION		**REASON**
9	Ammonia solution is a strong acid	because	silver chloride will dissolve in concentrated ammonia.
10	Sodium is in Group I of the Periodic Table	because	sodium nitrate liberates oxygen when heated.
11	Concentrated nitric acid renders iron 'passive'	because	nitric acid is an oxidizing agent.
12	Silver nitrate is reduced to the metal when heated	because	silver is low in the Activity Series.
13	Ammonium chloride is ionic in character	because	ammonium chloride sublimes on heating.
14	When ammonia is passed over hot copper(II) oxide a residue of copper is left	because	ammonia is a reducing agent.

15 Which of the following illustrate the acidic properties of dilute nitric acid?

1 nitric acid corrodes the skin
2 nitrates are formed on reaction with basic oxides.
3 carbon dioxide is liberated from carbonates

16 Which of the following are necessary in order to carry out a test for a nitrate ion in solution?

1 concentrated sulphuric acid
2 iron(II) sulphate solution
3 universal indicator

17 Which of the following are correct statements with respect to ammonia?

1 combines directly with chlorine
2 can not be dried using calcium chloride
3 burns in oxygen to produce nitrogen and water

18 Which of the following reactions will take place between copper(II) sulphate solution and the named reagents?

1 white precipitate with calcium nitrate
2 deep blue colouration with concentrated ammonia
3 evolution of brown fumes with moderately concentrated nitric acid

19 Which of the following occur when phosphorus is added to concentrated nitric acid?

1 heat is evolved
2 the phosphorus is oxidized
3 brown fumes are evolved

20 If the reaction between nitrogen and hydrogen is in accordance with Avogadro's hypothesis which of the following are correct?

1 one molecule of nitrogen is required to produce two molecules of ammonia
2 the volume of hydrogen is greater than the volume of ammonia produced
3 the ratio of volumes of reactants to products is 1:2

Questions 21 to 25

The following are five phenomena which either occur during, or which influence, a chemical change.

A crystallization
B dissociation
C neutralization
D esterification
E distillation

21 Which is the name of the type of reaction which takes place between glycerol and concentrated nitric acid?

22 Which occurs when excess aqueous calcium nitrate is added to dilute sulphuric acid?

23 Which occurs when potassium nitrate is strongly heated?

24 Which occurs when a hot saturated solution of sodium nitrate is allowed to cool?

25 Which applies to the following reaction?

$$3NH_4^+(aq) + 3\,0H^-(aq) + Al^{+++}(aq) + 3NO_3^-(aq)$$
$$\rightarrow Al(OH)_3(c) + 3NH_4^+(aq) + 3NO_3^-(aq)$$

CARBONATES

1 Which of the following hydrated carbonates is efflorescent at room temperature?

A ammonium **B** sodium **C** calcium
D copper(II) **E** iron(II)

2 Which of the following is responsible for the hardness of temporary hard water?

A magnesium sulphate
B lead chloride
C sodium stearate
D sodium carbonate
E calcium hydrogen carbonate

3 All of the following apply to carbon dioxide *except:*

A acidic in character
B is reduced when heated with carbon
C supports the combustion of sulphur
D covalent in character
E a product of the thermal decomposition of lead carbonate

4 Why is hydrochloric acid used in preference to sulphuric acid in the laboratory preparation of carbon dioxide from calcium carbonate?

A sulphuric acid is a weak acid
B hydrochloric acid is ionic in character
C calcium chloride absorbs water
D calcium sulphate is almost insoluble in water
E one mole of calcium carbonate will neutralize two moles of hydrochloric acid

5 What volume, in cubic decimetres, of carbon dioxide will be obtained when 10 moles of calcium carbonate is thermally decomposed at 273 °C and 1 atmosphere pressure?

A $22{\cdot}4 \times 10$ **B** $\dfrac{22{\cdot}4 \times 10}{273}$

C $\dfrac{22{\cdot}4 \times 10}{2}$ **D** $\dfrac{22{\cdot}4 \times 10 \times 2}{100}$

E $\dfrac{22{\cdot}4 \times 10}{100 \times 273}$

6 Why is it necessary to soften hard water in the home?

A a precipitate forms with washing soda
B hard water is unfit for drinking
C forms a solid residue in hot-water pipes and kettles
D hard water is acid
E dissolved salts raise the boiling point of water

7 Which of the following carbonates leaves a solid residue on heating which is yellow when hot and white when cold?

A lithium **B** copper(II) **C** iron(II)
D mercury(II) **E** zinc

8 Solutions of the following carbonates were prepared. Which carbonate will *not* decompose if the crystals obtained from solution are strongly heated in a bunsen flame?

A sodium **B** calcium **C** magnesium
D zinc **E** lead(II)

	ASSERTION		**REASON**
9	No precipitate is formed when aqueous solutions of sodium carbonate and lead(II) nitrate are mixed	because	sodium carbonate solution has a pH = 9.
10	Ammonium carbonate is not an ionic compound	because	no reaction occurs between aqueous solutions of silver nitrate and ammonium carbonate.
11	$Ca(OH)_2(c) + Na_2CO_3(aq) \rightarrow 2NaOH(aq) + CaCO_3(c)$	because	sodium is higher in the Activity Series than calcium.

12 Magnesium forms a crystalline hydrogen carbonate because aqueous solutions of magnesium sulphate and sodium hydrogen carbonate form a precipitate when the solutions are mixed and then heated.

13 Permanently hard water contains dissolved magnesium sulphate because no lather is formed when a small quantity of soap is added to hard water.

14 $CO_3^{--}(aq) + 2H^+(aq) \rightarrow CO_2(g) + H_2O(l)$ because the compound of formula H_2CO_3 is a strong acid.

15 In which of the following reactions is carbon dioxide a product?

1 when carbon monoxide is passed over hot lead(II) oxide
2 action of concentrated sulphuric acid on oxalic acid crystals
3 when steam is passed over white hot coke

16 Why is it possible to collect carbon dioxide by the upward displacement of air?

1 air diffuses faster than carbon dioxide
2 air is less dense than carbon dioxide
3 carbon dioxide does not react with air

17 Calcium carbonate occurs as calcite crystals. Which of the following support the theory that calcite is ionic?

1 sodium nitrate can be overgrown on a calcite crystal
2 all the crystals have the same angles between the faces
3 calcite crystals may be cleaved with a sharp instrument

18 Which of the following describe the action of heat on calcium carbonate?

1 thermal dissociation

2 reversible reaction
3 decarboxylation

19 Why are detergents added to water used in a laundry in a hard-water area?

1 detergents are synthetic
2 detergents form a lather with hard water
3 no solid residue (scum) is formed

20 Why is sodium hydroxide added to very soft water obtained from moorland areas?

1 to prevent lead salts dissolving
2 to increase the sodium ion concentration
3 to increase the pH of the solution

Questions 21 to 25

Each of the following is a physical process used in chemistry. Select the response necessary to answer the questions set out below.

A titration
B crystallization
C saturation
D decantation
E adsorption

21 Which applies to the separation of a mixture of coloured dyes by a column of finely powdered detergent?

22 Which may be used to indirectly determine the mass of carbon dioxide present in one mole of a soluble carbonate?

23 Which may be used to partially separate the deposit formed from the 'mother liquor' when hard water is softened by a precipitation method?

24 Which may be used to prepare a reasonably pure specimen of sodium carbonate decahydrate?

25 Which has occurred when a solid residue of a carbonate is observed at the bottom of an aqueous solution of the carbonate?

SULPHATES

1 Which of the following aqueous solutions of chlorides will give a precipitate on the addition of a solution of a soluble sulphate?

A sodium
B calcium
C magnesium
D copper(II)
E iron(II)

2 Which of the following remains as a solid residue when hydrated iron(II) sulphate is thermally decomposed?

A iron
B iron(II) oxide
C iron(III) oxide
D tri-iron tetroxide
E iron(III) sulphate

3 Which of the following equations illustrates the oxidizing ability of concentrated sulphuric acid?

A $C_x(H_2O)_y(c) \rightarrow x\,C(c) + y\,H_2O(l)$
B $2OH^-(aq) + 2H^+(aq) \rightarrow 2H_2O(l)$
C $2NH_3(g) + H_2SO_4(l) \rightarrow (NH_4)_2SO_4(c)$
D $Zn(c) + 2H_2SO_4(l) \rightarrow ZnSO_4(aq) + 2H_2O(l) + SO_2(g)$
E $NaCl(c) + H_2SO_4(l) \rightarrow NaHSO_4(c) + HCl(g)$

4 Which of the following aqueous solutions will not give a precipitate when added to a solution of a soluble sulphate?

A mercury(II) nitrate
B lead(II) acetate
C iron(II) chloride
D silver nitrate
E calcium chloride

5 Which of the following compounds is efflorescent at room temperature?

A concentrated sulphuric acid
B sodium sulphate decahydrate
C iron(III) sulphate
D magnesium sulphate heptahydrate
E calcium sulphate dihydrate (gypsum)

6 When dilute sulphuric acid is added to copper(I) oxide the solution turns blue and a red precipitate is formed. What is the red precipitate?

A copper(I) sulphide
B copper(I) sulphate
C copper(I) hydroxide
D copper(II) oxide
E copper metal

7 What is the name given to the type of reaction which occurs when zinc powder is added to aqueous copper(II) sulphate?

A addition
B substitution
C replacement
D dissociation
E double decomposition

8 Why is a salt containing the radical HSO^-_4 known as an acid salt?

A the radical liberates hydrogen ions in aqueous solution
B the radical contains hydrogen
C the sulphate radical is present
D a salt containing the radical is derived from sulphuric acid
E the radical has a negative charge

	ASSERTION		**REASON**
9	Iron(II) sulphate crystals are green	because	iron exhibits variable valency.
10	Copper(II) sulphate solution is blue	because	hydrated copper(II) ions are blue.
11	Lead(II) sulphate is very soluble in water	because	lead is in Group 2 of the Periodic Table.
12	Sodium sulphate is a base	because	an aqueous solution of sodium sulphate has a pH = 7.
13	The addition of concentrated sulphuric acid to water is endothermic	because	heat is gained by the surroundings.
14	Aluminium sulphate can be used to stop the flow of blood from small cuts	because	aluminium sulphate will coagulate proteins.

15 Which of the following would be observed when hydrated sodium sulphate is warmed gently in a test-tube, allowed to stand and then seeded with a small sodium sulphate crystal?

1 crystals melt **2** evolution of heat
3 effervescence

16 Which of the following apply to the neutralization of 5 M sulphuric acid by 10 M sodium hydroxide?

1 heat is evolved when equal volumes of acid and alkali are mixed
2 25 cm^3 of acid are equivalent to 25 cm^3 of alkali
3 phenolphthalein may be used as an indicator

17 Which of the following will be observed when a warm, strong solution of sulphuric acid is added to a small quantity of sodium sulphite?

1 effervescence **2** brown fumes
3 a solid residue

18 Why is no hydrogen evolved when lead is added to dilute sulphuric acid?

1 lead sulphate is insoluble in water
2 lead exhibits variable valency
3 lead is below hydrogen in the Activity Series

19 Why is concentrated sulphuric acid used in the 'brown ring' test for nitrates?

1 the acid prevents the formation of iron(III) sulphate
2 sulphuric acid has a greater density than water
3 a nitrate will react with concentrated sulphuric acid to give free nitric acid

20 Which of the following occur when 0·1 gram-atom of magnesium is added to 1 cubic decimetre of 0·1 M sulphuric acid?

1 precipitation **2** oxidation
3 neutralization

21 Why is the acid used in excess when iron(II) sulphate is prepared from iron filings and dilute sulphuric acid?

A to completely neutralize the acid

B otherwise the salt will not be hydrated
C to prevent oxidation of the iron(II) salt
D so that all the iron will dissolve
E to increase the rate of reaction

22 Why are *all* metallic sulphates considered to be ionic in character?

1 sulphates have fixed melting points
2 aqueous solutions of the salts will conduct electricity
3 all the crystals of a given sulphate have the same shape

	ASSERTION		**REASON**
23	A piece of paper moistened with potassium dichromate will turn green when held above a test-tube containing sulphur and concentrated sulphuric acid	because	potassium dichromate is used to test for the presence of hydrogen sulphide.

24 Why is iodine vapour evolved when hot, concentrated sulphuric acid is added to a solid iodide?

1 the vapour evolved is purple in colour
2 an iodide contains iodine
3 the iodide is oxidized

25 Why is the addition of aqueous barium nitrate to a suspect sulphate solution a *better* test for a sulphate than the addition of barium chloride?

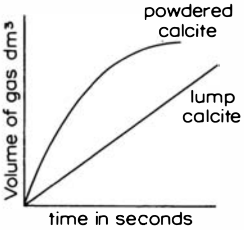
A barium nitrate is a soluble salt
B barium chloride will precipitate lead(II) chloride from a solution of lead(II) acetate
C only sulphates will give a dense white precipitate with barium nitrate
D one sulphate ion has twice the electric charge present on a nitrate ion
E precipitation will occur in acid or neutral solution

CHLORIDES and HYDROCHLORIC ACID

1 Which of the methods given below can be used to physically separate dissolved chlorides from sea-water?

A decantation **B** ionization **C** precipitation
D distillation **E** filtration

2 The graph sketched below is an indication of the results obtained when 5 M hydrochloric acid was added to calcite, the mass of calcite used being the same in each case. Why are the graphs different?



A different concentrations of calcite were used
B volume of gas evolved is independant of mass of solid
C the reaction is irreversible
D powdered calcite catalyses the reaction
E the rate at which the reaction proceeds depends on particle size

3 Which of the following chlorides does *not* exist in a crystalline form at room temperature?

A ammonium **B** calcium **C** carbon
D iron(II) **E** lead(II)

4 Which of the following moist chlorides is photo-sensitive?

A iron(II) **B** silver **C** lithium
D zinc **E** aluminium

5 Which of the following compounds will *not* oxidize hydrochloric acid to chlorine?

A manganese(IV) oxide **B** potassium permanganate
C bleaching powder **D** hydrogen peroxide
E sodium sulphite

6 When dry hydrogen chloride is passed over heated iron wire, hydrogen is evolved and a solid residue is deposited in a cooler part of the apparatus. Which of the following is a correct conclusion to the experiment?

	Reaction Type	*Name of Solid*
A	redox	iron(II) chloride
B	neutralization	iron(III) chloride
C	replacement	iron(II) chloride
D	combination	iron(III) chloride
E	sublimation	iron(II) chloride

7 Which of the following will *not* change in colour when added to dilute hydrochloric acid?

A blackberry juice **B** purple cabbage
C universal indicator **D** phenolphthalein
E methyl orange

8 Why does the addition of sodium chloride to ice, at the ice point, cause the ice to melt?

A sodium chloride is ionic
B sodium chloride is soluble in water
C the addition of salt to ice is an endothermic process
D the salt combines chemically with the ice
E ice and salt form a simple eutectic mixture

	ASSERTION		**REASON**
9	A potassium chloride crystal is a face-centred, cubic crystal	because	one ion of potassium is surrounded by six chloride ions.
10	Dry hydrogen chloride is an acid	because	a solution of hydrogen chloride in water has a pH < 7.
11	1 gram-atom of zinc will neutralize 1 cubic decimetre of 2 M hydrochloric acid	because	1 mole of hydrochloric acid contains 1 mole of hydrogen.

12 All metallic chlorides are white crystalline solids because the chloride ion is colourless.

13 The ionic chlorides of metals low in the Activity Series are insoluble in water because the chemical properties of the metals are a function of the electronic configuration of their atoms.

14 Calcium chloride hexahydrate is deliquescent because all metallic chlorides lose water of crystallization on heating.

15 Which of the following take place when aqueous solutions of a chloride and silver nitrate are mixed?

1 precipitation
2 double decomposition
3 a loss of energy to the surroundings

16 Why is hydrogen chloride evolved when concentrated sulphuric acid is added to crystalline sodium chloride?

1 hydrogen chloride is the most volatile component
2 the reaction is exothermic
3 sulphuric acid is a dehydrating agent

17 When crystals of hydrated iron(II) chloride are heated gently in a test-tube the crystals melt, a gas is evolved which gives white fumes with concentrated ammonia and a solid residue is left. Which of the following assumptions are correct?

1 the crystals dissolve in water of crystallization
2 the gas evolved is chlorine
3 the residue is yellow in colour

18 Which of the following explain the formation of a clear green solution when a slight excess of concentrated hydrochloric acid is added to solid copper(II) oxide?

1 copper(II) oxide is black and the acid is colourless
2 the resulting solution contains a dissolved salt
3 the copper(II) ion is only blue when hydrated

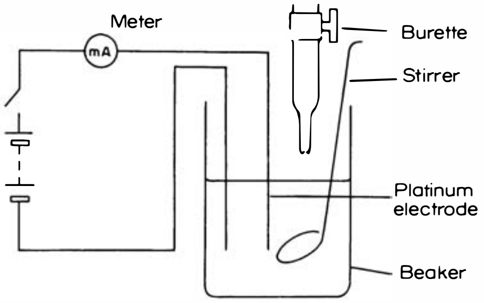
19 Why is it possible to separate the chlorides of sodium and potassium by fractional crystallization?

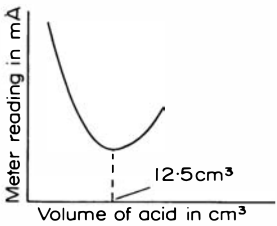
1 sodium is more electronegative than potassium
2 sodium and potassium chlorides form stable anhydrous crystals at room temperature
3 the solubility of sodium chloride is less than the solubility of potassium chloride at room temperature

20 25 cm^3 of 0·1 M potassium chloride were added to 25 cm^3 of 0·1 M lead(II) nitrate and the resulting solution was filtered. What happens when 25 cm^3 of 0·1 M hydrochloric acid are added to the filtrate?

1 the acid is exactly neutralized by lead(II) nitrate
2 $Pb^{++}(aq) + 2Cl^-(aq) \leftrightharpoons PbCl_2(c)$
3 the pH of the solution is increased

21





Using the arrangement shown in the diagram hydrochloric acid was added from the burette to 25 cm^3 of 0·1 sodium carbonate solution. Why was a graph of meter reading against volume of acid added as shown?

A pH value is a function of hydrogen ion concentration
B the minimum occurs when the acid is completely dissociated

C the conductivity of a solution depends upon the number of ions present
D dilution increases as the acid is added
E the minimum indicates the evolution of carbon dioxide

22 In the previous question the graph indicates that the minimum occurs when 12·5 cm³ of the acid were added from the burette, this was because
1 $CO_3^{--}(aq) + 2H^+(aq) \rightarrow H_2O(l) + CO_2(g)$
2 $CO_3^{--} \equiv 2e \equiv 2H^+$
3 the acid strength was 0·4 M

Questions 23 to 25

Each of the remaining questions apply to the list of gases set out below. Select the response which you consider to be correct.

A sulphur dioxide
B hydrogen sulphide
C carbon dioxide
D nitrogen oxide
E hydrogen

23 Which is evolved when moderately concentrated hydrochloric acid is added to sodium sulphite?

24 Which is evolved when dilute hydrochloric acid is added to a mixture of iron filings and sulphur?

25 Which is evolved when dilute hydrochloric acid is warmed with aqueous sodium nitrite?

HALIDES

1 Which of the following is used to test for the presence of chlorine gas?

A change in colour of acidified potassium dichromate, from orange to green
B white precipitate with silver nitrate solution
C potassium permanganate solution becoming decolourized
D a green gas which bleaches moist litmus
E a brown gas, acid to universal indicator

2 Which of the following groups of reagents can not be used in the preparation of a halogen (chlorine, bromine or iodine) in the free state?

A halogen acid, potassium permanganate
B sodium halide, manganese dioxide, concentrated sulphuric acid
C sodium halide, concentrated sulphuric acid
D halogen acid, manganese dioxide
E sodium halide, bleaching powder, dilute sulphuric acid

3 Why does an aqueous solution of potassium iodide turn brown on the addition of chlorine water?

A the iodide ion is reduced
B the reaction is an example of chlorination
C iodine is sparingly soluble in water
D chlorine is more electronegative than iodine
E iodine is a solid at room temperature

4 *All* of the following apply to the chloride, bromide and iodide of sodium *except:*

A ionic of type M^+X^-
B cubic crystals
C mass of 1 mole increases from chloride to iodide
D density increases from chloride to iodide
E efflorescent at room temperature

5 Why is it possible to use sulphur dioxide to remove excess chlorine left in water from the initial stages of purification of drinking water?

A chlorine oxidizes aqueous sulphur dioxide to sulphuric acid
B sulphur dioxide is an acid gas
C the reaction between chlorine and water is reversible
D addition of sulphur dioxide changes the pH of the solution
E chlorine will combine with aqueous sulphur dioxide

6 Which of the following is in support of the fact that the ease of thermal decomposition of the hydrogen halides follows the sequence: HI > HBr > HCl > HF?

A hydrogen fluoride is liquid at STP
B hydrogen chloride is a product of the thermal decomposition of ammonium chloride
C hydrogen iodide changes colour to violet on moderate heating
D dry hydrogen chloride is a non-conductor
E hydrogen fluoride will etch glass

7 Which of the equations set out below is an example of a redox reaction in which the valency (combining power) of a *cation* is changed and an *anion* loses electrons?

A $FeCl_3(c) + 3H_2O(aq) \rightarrow Fe(OH)_3(c) + 3HCl(aq)$
B $2Al(c) + 3Cl_2(g) \rightarrow 2AlCl_3(c)$
C $KBr(c) + H_2SO_4(c) \rightarrow KHSO_4(c) + HBr(g)$
D $2Cu^{++}(aq) + 4I^-(aq) \rightarrow 2CuI(c) + I_2(c)$
E $HgCl_2(aq) + 2I^-(aq) \rightarrow HgI_2(c) + 2Cl^-(aq)$

8 Which of the compounds containing chlorine, given below, will liberate chlorine on the addition of a dilute mineral acid?

A sodium chlorate
B sodium hypochlorite
C iron(III) chloride
D ammonium chloride
E chlorine water

	ASSERTION		**REASON**
9	A solution of bromine in water is acid	because	bromine is very soluble in water.

10	A mixture of chlorine and methane will explode in direct sunlight	because	a mixture of hydrogen and chlorine will explode in direct sunlight.
11	When chlorine is passed through an acidified solution of iron(II) chloride a colour change will be observed	because	chlorine is a strong oxidizing agent.
12	Bromine will not displace iodine from an iodide	because	iodine is more dense than bromine.
13	The solubility of sodium chloride (moles per cubic decimetre of water) only increases slightly between room temperature and steam point	because	sodium chloride is an ionic compound.
14	Iodine will turn a slice of potato a deep blue colour	because	a potato contains a carbohydrate which combines with iodine.

15 Which of the following explain the oxidizing action of the halogens?

1 incomplete outermost electron shell containing 7 electrons
2 the halogens are non-metallic in character
3 ammonia combines directly with the halogens

16 Which of the following can be used to show that a chemical change takes place when chlorine gas is passed into hot, concentrated potassium hydroxide solution?

1 the pH of the solution changes
2 two different crystals can be obtained on crystallization
3 one of the products of crystallization will liberate oxygen on heating

17 Which of the following are in support of the statement: 'the ionic radii of the halogens increases from fluorine to iodine'?

1 aqueous hydrogen chloride is an acid
2 fluorine has the greatest tendency to form anions
3 silver iodide is insoluble in concentrated ammonia and non-ionic in character

18 Why does hydrogen sulphide decolourize bromine water?

1 hydrogen sulphide is a reducing agent
2 hydrogen bromide is colourless
3 sulphur is precipitated

19 Why is bromine used in experiments to illustrate diffusion?

1 bromine diffuses more rapidly than hydrogen
2 the air does not react with bromine
3 bromine vapour has a distinctive colour

20 Why is oxygen evolved from chlorine water which has been standing for some time?

1 hypochlorous acid liberates oxygen in sunlight
2 chlorine displaces oxygen from water
3 chlorine ionizes in aqueous solution

21 What happens when 25 cm^3 of a molar solution of silver nitrate are added to 25 cm^3 of a molar solution of a sodium halide?

1 $Ag^+(aq) + X^-(aq) \rightarrow AgX(c)$
2 0·025 mole of silver halide precipitate
3 the silver ion is reduced

	ASSERTION		**REASON**
22	Ammonia diffuses at a faster rate than hydrogen chloride	because	nitrogen has a smaller atomic mass than chlorine.

23 What is the importance of concentrated hydrochloric acid in the flame test?

A to oxidize the material under test
B to chemically clean the support for the specimen
C to ensure that the halide of the metal is present

D lead chloride is soluble in concentrated hydrochloric acid

E other mineral acids give a colour to the flame

24 Which of the following could be used in an experiment involving *direct* titration procedures to determine the amount of chlorine present in tap water?

A bromine
B sodium hydroxide
C soap solution
D lime water
E silver nitrate

25 *All* of the following gases can be dried by anhydrous calcium chloride *except*:

A chlorine
B nitrogen
C carbon monoxide
D ammonia
E sulphur trioxide

OXIDES OF NON-METALS

Questions 1 to 5

These questions refer to the list of gases set out below. Select the response which you think answers the question correctly.

A	sulphur dioxide	**B**	carbon monoxide
C	dinitrogen tetroxide	**D**	hydrogen peroxide
E	sulphur trioxide		

1 Which will dissolve sparingly in water to give a solution of pH = 7?

2 Which decomposes on the addition of finely-divided platinum?

3 In which does the non-metal appear to have a combining power of 6?

4 Which will thermally decompose according to the equation:

$$1 \text{ mole P} \leftrightharpoons 2 \text{ moles Q}$$

5 Which poisons by direct combination with haemoglobin?

6 Why is lead(II) nitrate used in the laboratory to prepare a reasonably pure sample of nitrogen dioxide in preference to other nitrates?

A the salt may be thermally decomposed
B both nitrogen dioxide and oxygen are liberated
C the residue is a basic oxide
D lead(II) nitrate is anhydrous
E lead salts do not attack glass

7 Which of the following will *continue* to burn when plunged into a container of sulphur dioxide?

A	sulphur	**B**	carbon	**C**	magnesium
D	lead	**E**	copper		

8 Which of the equations given below is an example of oxidation by the oxide of a non-metal (excluding water)?

A $2H_2S(g) + SO_2(aq) \rightarrow 3S(c) + 2H_2O(l)$
B $2NO_2(g) \rightarrow 2NO(g) + O_2(g)$
C $H_2(g) + CO(g) + H_2O(g) \rightarrow 2H_2(g) + CO_2(g)$
D $PbO(c) + CO(g) \rightarrow Pb(c) + CO_2(g)$
E $SO_2(g) + H_2O(l) + HClO(aq) \rightarrow HCl(aq) + H_2SO_4(aq)$

	ASSERTION		**REASON**
9	Hydrogen peroxide is an acidic oxide	because	hydrogen peroxide will oxidize hydrogen sulphide to sulphur.
10	The oxides of nitrogen are *not* ionic in character	because	the bonding between the elements is due to the sharing of electrons.
11	Magnesium burns at a high temperature	because	burning magnesium will decompose nitrogen dioxide.
12	*All* the oxides of non-metals dissolve in water to produce an acid	because	a solution of sulphur dioxide in water contains hydrogen ions.
13	Sulphur dioxide will decolourize bromine water	because	bromine is oxidized to bromide ions.
14	Dinitrogen oxide can *not* be distinguished from oxygen	because	dinitrogen oxide will rekindle a glowing splint.

15 Why is a brown colouration observed when acidified hydrogen peroxide is added to an aqueous solution of an iodide?

1 hydrogen peroxide is an oxidizing agent
2 the brown colouration is free iodine
3 $2I^-(aq) - 2e \rightarrow I_2(c)$

16 Why is the formula of nitrogen oxide given as NO?

1 2 molecules of nitrogen oxide combine with copper to give 1 molecule of nitrogen and copper(II) oxide

2 the molecular mass of nitrogen oxide is 30
3 nitrogen oxide forms a loosely bound addition compound with iron(II) sulphate

17 Which of the following can be used to distinguish between hydrogen and carbon monoxide?

1 solubility in water
2 explosive combination with oxygen
3 colour of flame when burning in air

18 Which of the following reactions take place in order to produce a blue flame above a thick layer of red-hot coke?

1 $C(s) + O_2(g) \rightarrow CO_2(g)$
2 $CO_2(g) + C(c) \rightarrow 2CO(g)$
3 $2CO(g) + O_2(g) \rightarrow 2CO_2(g)$

19 Why is no *additional* acid required to bring about the decolourizing of potassium permanganate by the addition of aqueous sulphur dioxide?

1 sulphuric acid is a product of the reaction
2 potassium permanganate is an oxidizing agent
3 the rate of reaction depends only on the temperature

20 Which of the following characteristics of acidic oxides apply *only* to the oxides of nitrogen?

1 very soluble in cold water
2 able to combine chemically with water
3 acidity increases as the proportion of oxygen in the molecule increases

21 Which of the following gases is *not* obtained in the laboratory by the oxidizing action of a hot, concentrated acid?

A carbon dioxide
B sulphur dioxide
C nitrogen oxide
D nitrogen dioxide
E sulphur trioxide

22 Which of the following gases can be obtained by the thermal decomposition of a concentrated, non-crystalline acid?

A nitrogen dioxide
B dinitrogen oxide

C hydrogen peroxide **D** carbon monoxide
E carbon dioxide

	ASSERTION		REASON
23	Sulphur trioxide is the acid anhydride of sulphuric acid	because	sulphur trioxide is evolved when concentrated sulphuric acid is heated in a silica tube.

24 Which of the following apply to the mixture of gases given off when anhydrous copper(II) or zinc sulphate is strongly heated?

1 a gaseous component will crystallize to white silky crystals below the ice-point
2 the gases will turn moist, blue litmus red
3 the gases are green in colour

25 Which of the following compounds is reduced by the action of hydrogen peroxide?

A hydrogen sulphide
B iron(II) sulphate
C potassium permanganate
D lead(II) sulphide
E concentrated hydrochloric acid

OXIDES OF METALS

Questions 1 to 5

These questions apply to the list of metallic oxides. Select the response from the list below which you think is the correct response to the question.

A zinc oxide **B** sodium monoxide
C tri-iron tetroxide **D** copper(II) oxide
E silver oxide

1 Which is yellow when hot and white when cold?

2 Which will dissolve in water to give a solution of $\text{pH} > 9$?

3 Which is thermally decomposed with the greatest ease and at a relatively low temperature?

4 Which is an amphoteric oxide?

5 Which is a mixed oxide?

6 Which of the following groups of reactants are used in the preparation of copper(I) oxide?

A copper(II) sulphate, sodium hydroxide
B copper, concentrated nitric acid
C copper(II) oxide, ethanol
D copper(II) sulphate, glucose, sodium hydroxide
E copper(II) sulphate, sodium hydroxide, ammonia

7 Which of the following can be reduced by gentle heating in a stream of hydrogen?

A sodium monoxide **B** magnesium oxide
C zinc oxide **D** aluminium oxide
E mercury(II) oxide

8 Which of the following oxides is reduced in a strongly exothermic reaction by the use of aluminium powder?

A iron(III) **B** magnesium **C** zinc
D lithium **E** calcium

	ASSERTION		**REASON**
9	Zinc oxide is a basic oxide	because	zinc oxide forms a salt with dilute sulphuric acid.

10 The oxides of sodium and potassium are ionic because all sodium and potassium salts are soluble in water.

11 Sodium is more reactive than magnesium because sodium burns in air to form an oxide.

12 $ZnO(c) + C(c) \rightarrow Zn(c) + CO(g)$ because carbon has a greater affinity for oxygen than zinc.

13 Magnesium burns in air at a high temperature because the more readily an element combines with oxygen the greater the energy set free.

14 Basic oxides are insoluble in water because iron(II) oxide is insoluble in water.

15 What happens when steam is passed over heated iron filings?

1 a reversible reaction occurs which attains equilibrium
2 a gas which will not support combustion is produced
3 a solid black residue remains

16 Which of the following are relevant to aluminium oxide?

1 soluble in strong alkalis and acids
2 has a low melting point
3 good conductor of electricity

17 Which of the following refer to the oxide of silver?

1 can not be formed by heating the metal in oxygen
2 powder-like, macromolecular structure
3 reduced to the metal by hydrogen

18 Which of the following may be considered as evidence that triplumbic tetroxide(Pb_3O_4) is a mixed, basic oxide?

1 the oxide is a crystalline solid at room temperature
2 the oxide is thermally decomposed at a high temperature

3 the oxide will react with dilute nitric acid to yield two different lead compounds

19 Which of the following will reduce copper(II) oxide to the metal?

1 methane **2** ammonia **3** hydrogen

20 Why is calcium oxide a suitable drying agent for some gases?

1 the reaction between the oxide and water is exothermic
2 the oxide can be obtained in powder or granular form
3 the oxide absorbs water to form a solid hydroxide

21 An oxide was dissolved in excess dilute sulphuric acid, and the resulting green solution was concentrated and allowed to crystallize. Green efflorescent crystals were obtained which on strong heating left a red-brown, powder-like residue. Which of the following was the *residue*?

A mercury(II) oxide
B lead(II) oxide
C iron(II) oxide
D iron(III) oxide
E copper(I) oxide

22 Which of the following will (i) increase the rate of decomposition of hydrogen peroxide and (ii) lower the temperature at which potassium chlorate will thermally decompose?

A tri-iron tetroxide
B manganese (IV) oxide
C lead (II) oxide
D mercury (II) oxide
E silver oxide

23 Fine, red-hot pieces of a metal were added to a vessel containing a *neutral* oxide. A black, *basic* oxide was formed together with a gas which was inert until heated above 1000 K. Which of the following is correct?

	Formula of neutral oxide	*Formula of basic oxide*
A	CO	PbO
B	CO_2	Na_2O
C	N_2O	CuO
D	NO	ZnO
E	H_2O	Fe_3O_4

24 Which of the following distinguish the monoxide of lithium from the monoxides of sodium and potassium?

1 formed by the thermal decomposition of the hydroxide
2 formed when the metal is exposed to oxygen
3 neutralizes aqueous acids to form a salt and water

	ASSERTION		**REASON**
25	Amphoteric oxides have the same chemical properties as basic oxides	because	amphoteric oxides will neutralize mineral acids.

ELECTROCHEMICAL SERIES and ELECTROLYSIS

Questions 1 to 5

These questions refer to the list given below. Select the response which you think is the correct answer to the question.

A carbon
B copper
C magnesium
D aluminium
E zinc

1 Which will be displaced from aqueous solution by iron filings?

2 Which is the most electropositive?

3 Which is used as the anode in the electrolysis of a saturated solution of brine?

4 Which is obtained in industry by electrolysis of a solution of the molten oxide?

5 Which is refined, after extraction from its ore, by electrolysis?

6 Which of the following electrodes would be required to electrolyse an aqueous solution of zinc bromide so that the product at the cathode would be zinc and at the anode, bromine?

	Anode	*Cathode*
A	carbon	carbon
B	zinc	zinc
C	platinum	platinum
D	zinc	carbon
E	zinc	platinum

7 Which of the following is the *best* conductor of electricity?

A distilled water
B aqueous sugar solution
C a polythene rod
D metallic iron
E a crystal of anhydrous sodium sulphate

8 Which of the following aqueous solutions will *not* liberate oxygen as a product at the anode when electrolysed using carbon electrodes?

A dilute sodium chloride
B copper(II) chloride
C copper(II) sulphate
D dilute sodium hydroxide
E sodium sulphate

	ASSERTION		**REASON**
9	Iron is used as the cathode in the electrolysis of fused sodium chloride in industry	because	sodium is more electropositive than iron.
10	Oxides of lead can *not* be reduced by hydrogen	because	hydrogen is more electropositive than lead.
11	Violet fumes are evolved when fused potassium iodide is electrolysed using carbon electrodes	because	the iodide ion is oxidized to iodine at the anode.
12	Calcium will *not* displace copper from aqueous copper(II) solution	because	calcium will displace hydrogen from water.
13	When concentrated hydrochloric acid is electrolysed using carbon electrodes the solution becomes more dilute	because	hydrogen is evolved at the cathode, and chlorine at the anode.
14	Sodium can be obtained by heating its oxide with carbon	because	carbon has a greater affinity for oxygen than sodium has for oxygen.

15 Which of the following apply to the simple cell diagram:

$Zn(c) \mid Zn^{++}(aq) : Cu^{++}(aq) \mid Cu(c) \quad E = +1{\cdot}08\ V$?

1 $Zn(c) \xrightarrow{-2e^-} Zn^{++}(aq)$
2 the e.m.f. of the cell is 1·08 V
3 the simple cell arrangement has a copper anode

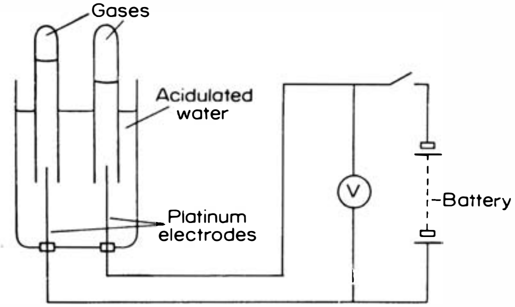
16 Why is it theoretically possible to construct a simple cell with hydrogen and magnesium as electrodes?

1 $Mg^{++}(aq) \mid Mg(c)$, $E = -2{\cdot}37$ V
2 hydrogen and magnesium do not react
3 hydrogen is a gas

17 Which of the following describe the 'standard electrode potential' of an electrode?

1 $H^+(aq) \mid H_2(g)$, Pt, $E = 0$
2 the 'E' value obtained when one component of the cell is a hydrogen electrode
3 the potential obtained when a single electrode is immersed in deionized water

18 The apparatus used in an electrolysis experiment was as shown in the diagram; V is a centre-zero voltmeter. Why was a reading observed on V when the switch was opened after electrolysis had been proceeding for some time?



1 the solution contains ions
2 the electrode potential of oxygen is positive with respect to hydrogen
3 the direction of flow of charge through the voltmeter is reversed

19 Which of the following are characteristic of metals low in the Activity Series?

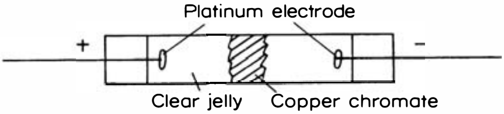
1 the carbonate is not decomposed by heat

2 the nitrate is decomposed by heat
3 not attacked by dilute mineral acids

20 In order to construct a fuel cell which of the following are necessary?

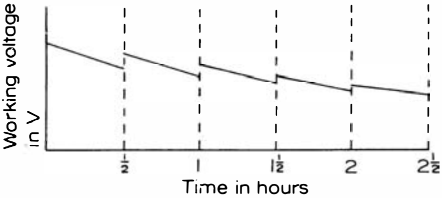
1. a rapid electron transfer between gas and electrode
2. the work obtainable from the reaction (ΔG) should have a large (negative) value
3. the electrode, or terminal, over which the gas is passed should not take part in the reaction

21 A potential difference is applied between the electrodes of the apparatus shown in the diagram. Why is a blue colour observed near the negative electrode after some time?



A copper chromate is an electrolyte
B the jelly conducts electricity
C chromium ions are blue in colour
D under the influence of an electric field unlike charges repel
E the positively charged copper ion migrates to the negative electrode

22 The graph sketched below is an indication of the variation of working voltage of a simple dry cell when used intermittently. The cell is rested for 1 hour after being used for 30 minutes, and in each test is discharged through the same resistance. Why does the graph take the shape shown?



A the current flow is constant for each period of use

B a back e.m.f. is set up during the rest period

C during the rest period the polarizing chemicals are oxidized

D if a small current is taken from the cell no polarization occurs

E the concentration of the electrolyte decreases as the time increases

23 Which of the following would give an 'E' value equal to $+1{\cdot}10$ V if:

Ag(c) | Ag^{+}(aq) E $= +0{\cdot}80$ V
Zn(c) | Zn^{++}(aq) E $= -0{\cdot}76$ V
Cu(c) | Cu^{++}(aq) E $= +0{\cdot}34$ V?

A Cu(c) | Cu^{++}(aq) ⋮ Ag^{+}(aq) | Ag(c)
B Zn(c) | Zn^{++}(aq) ⋮ H^{+}(aq) | H_2(g), Pt
C Ag(c) | Ag^{+}(aq) ⋮ Zn^{++}(aq) | Zn(c)
D Zn(c) | Zn^{++}(aq) ⋮ H^{+}(aq) | H_2(g),Pt,
Pt,H_2(g) | H^{+}(aq) ⋮ Cu^{++}(aq) | Cu(c)
E Cu(c) | Cu^{++}(aq) ⋮ Zn^{++}(aq) | Zn(c)

	ASSERTION		REASON
24	No reaction occurs between aluminium and steam	because	the surface of the metal is readily oxidized.

25 Which of the following explain the rusting of iron?

1 carbon dioxide dissolves in rain water to give an acid
2 a simple cell is set up at the surface of the iron
3 oxygen from the air acts as a depolarizer

CRYSTAL STRUCTURE and SOLUBILITY

Questions 1 to 5

These questions refer to the list given below. Select the response which you think is the correct answer to the question.

A silver
B sodium chloride
C naphthalene
D hydrated calcium chloride
E starch

1 Which is purified by recrystallization from acetone?

2 Which may be obtained from aqueous solution by a displacement method using mercury?

3 Which has the *greatest* solubility in water at room temperature?

4 Which is considered to be a 'macromolecule'?

5 Which is obtained in the crystalline state as a cubical, *close-packed* arrangement?

6 Which of the unit cells given below is the basis of the hydrated copper sulphate crystal ($CuSO_4.5H_2O$)?

A cubic
B triclinic
C monoclinic
D rhombohedral
E hexagonal

7 Why is the unit cell of sodium defined as a face-centred cube?

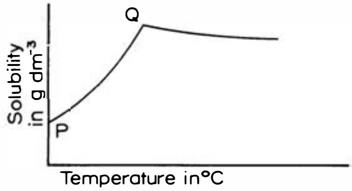
A large crystals obtained from solution are cubic
B one sodium ion combines with one chlorine ion
C the sodium ion at each corner of the unit cell is shared with the adjoining cell
D a sodium ion is situated at each corner of the cell and at the centre of each face
E the crystal has more than one plane of cleavage

8 Which of the following determine the mass of a solute which will dissolve in a given solvent?

A nature of solute, nature of solvent
B nature of solute, temperature of solvent
C nature of solute, nature of solvent, temperature of solvent
D temperature of solute, temperature of solvent, atmospheric pressure
E nature of solvent, temperature of solvent, temperature of solute

	ASSERTION		**REASON**
9	Magnesium oxide is *not* crystalline	because	when magnesium burns in oxygen the residue is a white ash.
10	The solubility of ammonia in water decreases with increased temperature	because	ammonia is a gas at normal temperature and pressure.
11	Crystals of lead and zinc are identical in all respects	because	lead crystals will grow on a zinc sheet immersed in lead nitrate solution
12	Air is a solution of gases	because	liquid air can be separated into different components by fractional distillation.
13	*All* organic solids are non-crystalline	because	a solution of naphthalene in water will not conduct electricity.
14	The solubility of potassium chlorate increases with temperature	because	the solubilities of *all* ionic compounds increase with increased temperature.

15 The graph of solubility against temperature for sodium sulphate is as shown because:



1 PQ is the curve for the hydrated salt
2 the solubility of the anhydrous salt decreases with increase in temperature
3 sodium sulphate ionizes:
$(2Na^{+}.SO_4^{--})(aq) \leftrightharpoons 2Na^{+}(aq) + SO_4^{--}(aq)$

16 Why does tetrachloromethane(CCl_4) form a layer above water when an attempt is made to dissolve it in water?

1 oil and water do not mix
2 water has the lowest density
3 tetrachloromethane is only partially soluble in water

17 Which of the following determine whether or not a solution is saturated at a given temperature?

1 the solution is homogeneous
2 crystals will form on cooling
3 excess solute is present which will not dissolve

18 Which of the following are necessary to determine the solubility of a gas in a liquid?

1 the temperature of the gas and liquid
2 the pressure at which solution occurs
3 the volume of gas which will saturate the given volume of liquid

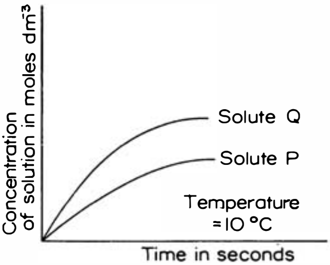
19 Why is heat evolved when concentrated sulphuric acid is diluted?

1 concentrated sulphuric acid is hygroscopic
2 the reaction: $SO_3(g) + H_2O(l) \rightarrow H_2SO_4(l)$ is exothermic
3 heats of ionization and dilution are evolved

20 Which of the following determine the size of crystal obtained from a solution?

1 degree of saturation of liquid
2 size of seed crystal
3 rate of cooling of solution

21 The graph is an indication of the results obtained for the rates at which solutes P and Q dissolve in 1 cubic decimetre of a solvent at a fixed temperature.



Which of the following are apparent from the information supplied on the graph?

A P will be more soluble than Q at a higher temperature
B P dissolves more slowly than Q under the given conditions
C Q is an ionic compound
D the solution containing P is saturated
E a low temperature is used because P and Q are gases

22 Which of the following determine the *shape* and *size* of the unit cell from which an ionic crystal is built?

A the angles between the corresponding faces of the crystal
B the number of planes of cleavage present in the crystal
C the size, shape and arrangement of the ions inside the cell
D the number of faces on the crystal
E X-ray diffraction patterns obtained from the crystal

23 Why is a slight precipitate formed when a freshly-prepared, saturated solution of calcium hydroxide is gently warmed?

A carbon dioxide is more soluble in warm water than cold
B dissolved calcium hydrogen carbonate is decomposed
C the hydroxide is converted to the oxide on heating
D increase in temperature facilitates the formation of calcium hydroxide crystals
E the solubility of calcium hydroxide decreases as the temperature increases

24 Which of the following solvents can be used to dissolve both an organic *and* an inorganic solute?

A anhydrous sulphuric acid
B tetrachloromethane
C benzene
D ethanol
E diethyl ether

	ASSERTION		**REASON**
25	The co-ordination number of sodium is four	because	four sodium ions surround one chlorine ion in any one plane of symmetry of a sodium chloride crystal

ALLOYS and ALLOTROPY

1 Which of the following is an alloy?

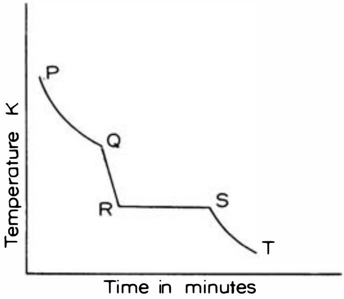
A polythene **B** silica
C steel **D** platinized asbestos
E vanadium

2 Which of the following types of sulphur is obtained when a solution of the element in carbon disulphide is allowed to crystallize?

A flowers of sulphur **B** amorphous
C plastic **D** rhombic
E monoclinic

3 A graph for the change in state of an alloy was obtained by plotting temperature against time as shown. Over which region of the cooling curve was the alloy in its *pasty* stage?

A PQ
B QR
C RS
D QRS
E RST



4 Which of the following is a *brittle* alloy?

A bronze (wrought)
B brass (cartridge)
C tin solder (60% tin)
D steel (high carbon content)
E iron (cast)

Questions 5 to 8
These questions apply to the list given below. Select the response which you think is the correct answer to the question.

A bronze **B** steel **C** solder
D cupro-nickel **E** constantan

5 Which is used in the making of 'silver' coinage?

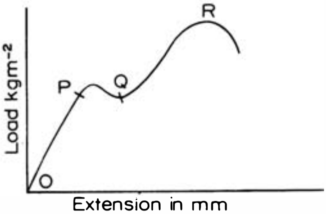
6 Which has the lowest melting point?

7 Which is used in the manufacture of electrical resistance wire?

8 Which is used to make corrosion resistant springs?

	ASSERTION		**REASON**
9	Graphite is an allotrope of carbon	because	graphite burns in oxygen to give carbon dioxide only.
10	The transition temperature is the temperature at which two crystalline forms of an element exist in equilibrium	because	rhombic sulphur changes to monoclinic sulphur at 95·5 °C.
11	Graphite is used as a lubricant	because	the graphite molecule consists of atoms arranged in 'planar' sheets.
12	Molten sulphur is an allotrope of sulphur	because	molten sulphur forms a crystalline sulphur when poured into cold water.
13	Metals expand on cooling	because	some alloys contain metals to ensure that the volume remains constant when the temperature changes.
14	Magnesium is *not* used for making alloys	because	magnesium is stronger than aluminium and difficult to work.

15 Which of the responses given below apply to the deformation curve obtained when a metal is stressed to its breaking point?



1 OP is elastic deformation
2 PQR is plastic deformation
3 the maximum, R, occurs at the point of fracture

16 Why is steel sometimes 'cold rolled'?

1 to increase the length of the specimen
2 to deform the crystals
3 in order to produce a harder steel

17 Why are small quantities of one metal, X, added to another, Y, when preparing an alloy?

1 to change the shape of the alloy X–Y
2 to prevent the spread of dislocations in Y
3 to increase the strength of Y

18 Which of the following determine the mechanical strength of an alloy?

1 hardness **2** malleability
3 corrosion resistance

19 Why is steel sometimes 'quenched' by plunging red-hot steel into cold water?

1 to increase the hardness of the steel
2 to render the specimen more malleable
3 to oxidize surface impurities

20 Which of the alloys given below are suitable for the construction of components used inside nuclear reactors?

1 zirconium **2** beryllium **3** magnesium

21 Why is sulphur said to exhibit polymorphism?

A the viscosity of molten sulphur changes with temperature
B some sulphur molecules contain eight atoms
C sulphur crystallizes in more than one form

D only non-metals exhibit polymorphism
E sulphur vapour condenses to amorphous sulphur

22 Which of the following describes the ability of an alloy to ‘resist’ fracture on impact?

A ductility **B** malleability **C** hardness
D toughness **E** elasticity

23 Which of the following metals is not suitable for the manufacture of a magnetic alloy?

A nickel **B** iron **C** cobalt
D lead **E** manganese

24 What is a simple eutectic mixture?

1 the melting point of the mixture is lower than that of its components
2 the components are insoluble in each other in the solid state
3 the components are completely miscible when molten

	ASSERTION		**REASON**
25	Sodium amalgam is an alloy	because	an alloy is formed when an element dissolves in a molten metal.

THE PERIODIC TABLE

Questions 1 to 5

These questions refer to the incomplete Periodic Table shown, in which the numbers 1a, etc., refer to the Groups of the table and the other four rows give the atomic numbers of the elements of the first four Periods of the table. The letters **A**, **B**, etc., refer to the questions set out below and are *not* the symbols of the elements. Therefore, select the response from the table which you think is the correct answer to the questions set out below.

1a	2a	3a	4a	5a	6a	7a	8			1b	2b	3b	4b	5b	6b	7b	0
1																	2 **B**
3	4											5	6	7 **D**	8	9	10
11	12 **C**											13	14	15	16	17	18
19	20	21	22	23	24	25	26 **E**	27	28	29 **A**	30	31	32	33	34	35	36

1 Which is an 'inert' gas?

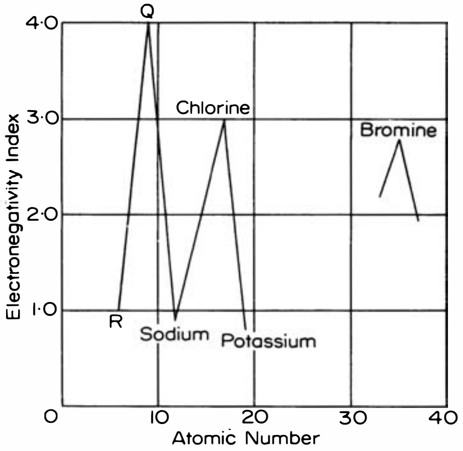
2 Which will form a strongly basic oxide?

3 Which is ferromagnetic?

4 Which will form coloured ions in solution?

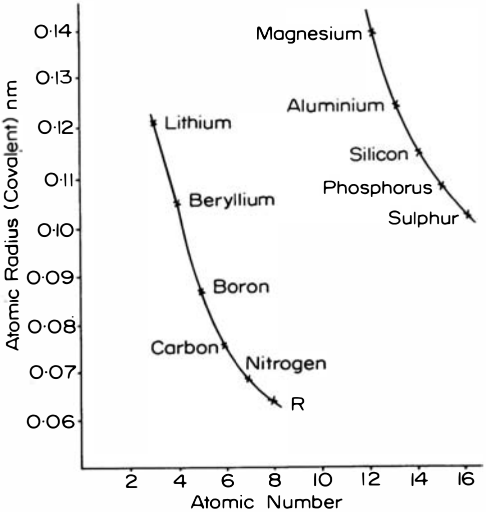
5 Which is the most electronegative?

6 The graph shows the variation of electronegativity of the elements with change in atomic number. Q is the most electronegative element in the Periodic Table. What is the name of the element shown as R (R is *not* the chemical symbol of the element)?



A fluorine **B** hydrogen **C** lithium
D neon **E** magnesium

7 The graph shows the variation of atomic radius (covalent radius) with increase in atomic number. What is the name of the element shown as R (R is *not* the chemical symbol of the element), if carbon and silicon are in the same Group of the Periodic Table and atomic radius is a periodic function of atomic number?



A silver **B** chlorine **C** fluorine
D oxygen **E** potassium

8 Why is lead placed in Group 4 of the Periodic Table?

- **A** the molar mass of the element is 0·2072 kg
- **B** the electronic configuration of lead is 2, 8, 18, 32, 18, 4
- **C** the chemical properties of lead are similar to those of tin
- **D** lead has a radioactive isotope
- **E** lead can exhibit variable valency

	ASSERTION		REASON
9	Magnesium is more electropositive than calcium	because	the ionic radius of calcium is smaller than that of magnesium.
10	The atomic volume of the elements increases across the Periodic Table from sodium to chlorine	because	sodium loses an electron more easily than chlorine.
11	Nitrogen is in Group 5 of the Periodic Table	because	nitrogen is relatively inert at room temperature.
12	Sodium and magnesium have similar melting points	because	sodium and magnesium can be obtained by electrolysis of their fused chlorides.
13	The melting point of magnesium oxide is higher than that of sodium monoxide	because	more heat is liberated when one mole of magnesium oxide is formed from its elements than when one mole of sodium monoxide is formed.
14	Aluminium exhibits both metallic and non-metallic character	because	aluminium can exhibit a valency (combining power- of 3 or 5.

15 Why do chromium and nickel form coloured ions in aqueous solution?

1 the elements have an incomplete penultimate shell (can exhibit a variable combining power)
2 the elements are metals
3 the elements can be used as catalysts

16 Why is carbon suitable for use as an electrode in many electrochemical reactions?

1 no other element conducts electricity as well as carbon
2 carbon is a Group 4 element and does not form ions
3 carbon is resistant to attack by chlorine and has a very high melting point

17 Why are the chlorides of Group 1 metals said to be metallic in character?

1 the salts are non-volatile
2 no hydrolysis occurs in aqueous solution
3 salts are electrolytes when fused or in aqueous solution

18 Which of the following is applicable to *all* the metals of Groups 1a and 2a?

1 the metals ionize by electron loss
2 the oxides are basic in character
3 the elements will displace hydrogen from dilute acids

19 Which of the following are exhibited by compounds of Group 5b elements?

1 the anhydrous hydrides are non-electrolytes
2 the chlorides are electrolytes
3 the chlorides are *not* hydrolysed by water

20 Which of the following are characteristic of the elements of Group 7b?

1 the elements are non-metals
2 ionization occurs when electrons are gained
3 the elements are strong reducing agents

21 Why is zinc considered to be a metal?

A the element is a solid at room temperature
B the oxide is amphoteric
C zinc dust will displace hydrogen from acids and alkalis
D zinc will combine directly with chlorine
E the element forms simple ions by electron loss

22 Why is magnesium said to have a molar mass of 24·31 g?

A magnesium is obtained from sea-water
B the mass of each atom is derived from the mass of carbon 12
C magnesium consists of a mixture of isotopes
D 1 mole contains more than Avogadro's number of atoms
E magnesium rapidly tarnishes in air

23 Which of the following is characteristic of the element of electronic configuration 2, 4?

A forms ions by electron loss
B will form an acidic and a neutral oxide
C does not conduct electricity
D is a gas at room temperature
E dissolves in a concentrated acid to give a salt and water

24 Which of the following are numerically equal to the atomic number of an element?

1 the order of the element in the Periodic Table
2 the number of electrons in a neutral atom
3 the number of protons and neutrons in a neutral atom

	ASSERTION		**REASON**
25	The valency of Group 8 elements is zero	because	the elements of Group 8 can not lose electrons.

GROUPS 1 and 2

1 Which of the following will form (i) a soluble nitrate and (ii) an insoluble chloride which is photosensitive?

A calcium **B** magnesium **C** copper
D silver **E** zinc

2 Why is it possible to extract zinc from its ore by reducing the oxide with carbon?

A zinc oxide is non-ionic
B zinc has a low melting point
C carbon is more electronegative than zinc
D zinc blende is converted to the oxide on heating in air
E for the reaction: $ZnO(c) + C(g) \rightarrow Zn(c) + CO(g)$, the change in free energy is a negative quantity

3 Which of the following has the largest atomic number?

A mercury **B** potassium **C** magnesium
D zinc **E** calcium

4 On heating a black powder on a charcoal block a red-brown deposit was observed and the residue was found to dissolve in concentrated hydrochloric acid to give a green solution. What was the original black powder?

A magnesium oxide **B** zinc carbonate
C copper(II) oxide **D** mercury(II) oxide
E silver oxide

5 Which of the following elements is the *least* electropositive?

A lithium **B** silver **C** beryllium
D copper **E** potassium

6 Which of the following is the formula of 'gypsum'?

A $CaCO_3$ **B** CaF_2
C $Ca_3(PO_4)_2$ **D** $CaSO_4.2H_2O$
E $CaCO_3.MgCO_3$

7 Which of the following is a soft, white metal, of den-

sity less than water and which has no naturally occuring isotopes?

A lithium **B** sodium **C** potassium
D calcium **E** magnesium

8 Which of the following elements will have the *least* value of heat of fusion per mole of the element?

A silver **B** magnesium **C** copper
D zinc **E** mercury

	ASSERTION		**REASON**
9	Sodium chloride is a hydrated salt	because	sodium has a great affinity for water.
10	An alloy of silver is used as a solder	because	silver is the best known conductor of heat.
11	Mercury(II) oxide changes colour on heating	because	oxygen is evolved when mercury(II) oxide is heated and the metal is left.
12	Silver may be extracted by electrolysis of the fused chloride	because	sodium is extracted by electrolysis of the fused chloride.
13	The heat of reaction of potassium with water is greater than that of sodium with water	because	when potassium is added to water the heat of reaction is sufficient to ignite the hydrogen evolved.
14	Calcium will not react with cold water	because	calcium is in Group 2 of the Periodic Table.

15 Which of the following reactions are characteristic of a particular Group 2 chloride?

1 $MCl_2(c) + 6C_2H_5OH(l) \rightarrow MCl_2 . 6C_2H_5OH(c)$
2 $MCl_2(c) + 6H_2O(l) \rightarrow MCl_2 . 6H_2O(c)$
3 $MCl_2(aq) + (NH_4)_2CO_3(aq) \rightarrow MCO_3(c) + 2NH_4Cl(aq)$

16 Which of the following are characteristic of potassium?

1 occurs naturally in the 'free' state
2 gives a lilac colour in the 'flame test'
3 does not react with paraffin oil at room temperature

17 Which of the following apply to mercury?

1 forms alloys with Group Ia metals
2 is displaced from solutions of its salts by zinc
3 can exhibit oxidation numbers of 2 and 4

18 Which of the following reactions are typical of copper salts?

1 $Cu(HCO_3)_2(c) \xrightarrow{\Delta} CuO(c) + H_2O(g) + 2CO_2(g)$
2 $Cu^{++}(aq) + Mg(c) \rightarrow Mg^{++}(aq) + Cu(c)$
3 $Cu^{++}(aq) + 2OH^-(aq) \rightarrow Cu(OH)_2(c)$

19 Which of the following reactions occur when sodium metal is exposed to moist air?

1 $4Na(c) + O_2(g) \rightarrow 2Na_2O(c)$
2 $Na_2O(c) + H_2O(l) \rightarrow 2NaOH(c)$
3 $2NaOH(c) + CO_2(g) \rightarrow Na_2CO_3 \,.\, H_2O(c)$

20 Which of the following compounds can be prepared by the action of chlorine on slaked lime?

1 calcium hypochlorite **2** calcium chloride
3 calcium chlorate

21 Which of the following aqueous solutions will give a very dark brown precipitate on the addition of sodium hydroxide?

A calcium chloride **B** zinc nitrate
C magnesium sulphate **D** copper(II) sulphate
E silver nitrate

22 Which of the following pairs of reactants may be used to prepare a soluble salt of calcium?

A calcium nitrate, sulphuric acid
B calcium nitrate, sodium carbonate
C calcium carbonate, hydrochloric acid
D calcium chloride, oxalic acid
E calcium carbonate, ammonium hydroxide

23 Which of the following aqueous solutions will give a precipitate with aqueous ammonia which will then dissolve in excess concentrated ammonia?

A magnesium sulphate **B** calcium nitrate
C lithium carbonate **D** zinc sulphate
E sodium thiosulphate

24 Which of the following compounds is *not* used as an oxidizing agent but *is* used to produce a weak mineral acid in aqueous solution?

A potassium permangante
B sodium dichromate
C potassium chlorate
D potassium nitrate
E sodium nitrite

	ASSERTION		**REASON**
25	Sodium chloride will turn a colourless bunsen flame yellow	because	sodium ions are yellow in colour.

GROUPS 3A, 4A and 5A

1 Which of the following elements will form an ion which has two positive charges?

A aluminium **B** lead **C** silicon
D nitrogen **E** phosphorus

2 Which of the following elements can exhibit an oxidetion number of 2 or 4?

A silicon **B** aluminium **C** tin
D nitrogen **E** phosphorus

3 Which of the following elements is the most abundant in the earth's crust?

A aluminium **B** phosphorus **C** lead
D carbon **E** silicon

4 Which of the following is an aluminium ore?

A cryolite **B** galena **C** cinnabar
D calamine **E** dolomite

5 Which of the following aqueous solutions will give a black precipitate when hydrogen sulphide is bubbled through?

A aluminium sulphate **B** nitric acid
C sodium silicate **D** orthophosphoric acid
E lead(II) acetate

6 Which of the following elements has five electrons in the outermost shell of each atom?

A silicon **B** tin **C** phosphorus
D aluminium **E** boron

7 Which of the following elements will form at least one oxide of each of the following types: basic, amphoteric, dioxide?

A aluminium **B** nitrogen **C** phosphorus
D lead **E** carbon

8 Three tests were carried out on different samples of an aqueous solution of a salt and the results were as indicated:

	Test	*Result*
(i)	universal indicator	pH < 7
(ii)	dilute nitric acid and silver nitrate solution were added	white precipitate
(iii)	dilute sodium hydroxide was added	white gelatinous precipitate

Which of the following was the salt?

A lead(II) nitrate
B lead(II) acetate
C aluminium chloride
D aluminium bromide
E tin(II) nitrate

	ASSERTION		**REASON**
9	Nitrogen is essential for plants and animals	because	free nitrogen forms approximately 80% of the atmosphere.
10	The thermal decomposition of ammonium dichromate is exothermic	because	gaseous nitrogen is evolved and the volume of the solid increases.
11	$2Al(c) + Fe_2O_3(c) \rightarrow Al_2O_3(c) + 2Fe(c)$; $-\Delta H$ kJ per mole	because	aluminium oxide has a low melting point.
12	Silicon is a good conductor of electricity	because	silicon is used in the manufacture of some transistors and diodes.
13	White phosphorus will ignite if touched with a red-hot glass or metal rod	because	white phosphorus has a low ignition temperature.
14	When a pure tin rod is deformed the 'cry' of tin can be heard	because	tin is a crystalline material.

15 Which of the following are characteristic of lead(II) oxide?

1 insoluble in dilute mineral acids
2 slightly soluble in water to give a solution of pH > 7

3 readily reduced by carbon, hydrogen and carbon monoxide

16 When a dark brown oxide of lead is heated a gas is evolved which will relight a glowing splint and a reddish-yellow residue remains. Which of the following are correct?

1 oxygen is evolved
2 thermal decomposition has occurred
3 the residue is an oxide of lead

17 Which of the following are used in the manufacture of domestic window glass?

1 sand
2 sodium carbonate
3 sodium sulphate

18 Why does a thin piece of aluminium, which has been immersed in mercury(II) chloride solution, flake and increase in temperature on exposure to air?

1 an amalgam of aluminium and mercury is formed
2 an exothermic reaction occurs
3 the oxide layer on the aluminium is removed enabling a reaction to occur

19 Why does aluminium liberate hydrogen from warm, dilute hydrochloric acid?

1 aluminium is more electropositive than hydrogen
2 rate of chemical reaction increases with temperature
3 aluminium chloride is soluble in water

20 Which of the following statements regarding *alums* are correct?

1 all alums contain aluminium
2 alums do not exhibit isomorphism
3 the general ionic formula of alums is: $X^{+} . Y^{+++} . 2SO_4^{--} . 12H_2O$, where X and Y are metals

21 Which of the following is the formula of a compound which can be used to dry ammonia gas?

A KOH
B H_2SO_4
C CaO
D $CaCl_2$
E P_2O_5

22 All of the following can be used to prepare nitrogen except:

- **A** ammonium nitrate
- **B** ammonium nitrite
- **C** copper and nitrogen oxide
- **D** sodium nitrite and ammonium chloride
- **E** copper and dinitrogen oxide

23 In which of the following reactions is a metal ion reduced?

- **A** $P(c) + 3Na(c) \rightarrow Na_3P(c)$
- **B** $2Al(c) + 3Cl_2(g) \rightarrow 2AlCl_3(c)$
- **C** $2P(c) + 5CuSO_4(aq) + 6H_2O(l) \rightarrow 5Cu(c) + 5H_2SO_4(aq) + 2HPO_3(aq)$
- **D** $3Mg(c) + N_2(g) \rightarrow Mg_3N_2(c)$
- **E** $2Pb(c) + 2H_2O(l) + O_2(g) \rightarrow 2Pb(OH)_2$

	ASSERTION		REASON
24	Lead has a high density	because	lead is a product of radioactive disintegration.

25 Which of the following changes take place between Group 3 and Group 5 of the Periodic Table?

- **A** the oxides become more stable to heat
- **B** solubility of metal salts increases
- **C** the elements become less electropositive
- **D** the chlorides of the elements become more ionic in character
- **E** the elements lose electrons more easily

GROUPS 6A, 7A and 8

Questions 1 to 5
These questions refer to the list of elements set out below. Select the response which you think is the correct answer to the question.

A sulphur **B** chromium **C** chlorine
D manganese **E** iron

1 Which forms an oxide, of the type XO_2, which is used to catalyse the decomposition of hydrogen peroxide?

2 Which has six electrons in its outermost shell?

3 Which can exhibit a valency (combining power) of one?

4 Which forms part of the anion of a salt which is red in colour and is a strong oxidizing agent?

5 Which forms part of the anion of a salt, which is purple in colour, when the element exhibits a valency of seven?

6 Which of the following compounds will give a gelatinous, reddish-brown precipitate when added to aqueous caustic alkali?

A iron(III) oxide
B iron(II) sulphate
C iron(III) sulphate
D chromium(III) sulphate
E chromium(III) chloride

7 Why is chlorine said to be a strong oxidizing agent?

A chlorine dissolves in water to give a bleaching agent
B oxidation occurs when electrons are lost
C iron will combine with chlorine to give iron(II) chloride
D alkali metals are obtained from their chlorides by electrolysis
E chlorine is very electronegative and readily accepts electrons

8 Which of the following aqueous solutions will turn yellow and not give a precipitate, on the addition of acidified potassium permanganate solution?

A iron(II) sulphate **B** hydrogen peroxide
C potassium iodide **D** hydrogen sulphide
E sodium sulphite

	ASSERTION		REASON
9	Iron(II) sulphate will decolourize bromine water	because	bromine forms addition compounds with divalent elements.
10	Iodine will displace chlorine from solutions of chlorides	because	iodine is more electronegative than chlorine.
11	$3Fe(c) + 4H_2O(l) \xrightarrow{\Delta} Fe_3O_4(c) + 4H_2(g)$	because	water is an oxidizing agent.
12	The mass of 1 mole of hydrogen sulphide is less than the mass of 1 mole of water	because	hydrogen sulphide is a gas at room temperature.
13	The formula of ozone is O_3	because	three molecules of oxygen can be obtained from two molecules of ozone.
14	The oxide of formula Fe_3O_4 is magnetic	because	all the oxides of iron are magnetic.

15 Which of the following was observed when amorphous sulphur was heated in a test-tube?

1 the solid melted to a pale yellow liquid
2 the liquid changed colour and viscosity
3 a pale yellow vapour was evolved at boiling point

16 In which of the following is oxygen reduced?

1 $O_2(g) + 2H_2(g) \rightarrow 2H_2O(l)$
2 $C(c) + O_2(g) \rightarrow CO_2(g)$
3 $2H_2O_2(l) \rightarrow 2H_2O(l) + O_2(g)$

17 Iron filings were added to dilute hydrochloric acid and the gas evolved was dried and then passed through molten sulphur. Which of the following are properties of the final gaseous product, produced when the initial gas reacted with the sulphur?

1 burns with a blue flame in air
2 just acid to universal indicator when moist
3 will not react with chlorine or moist sulphur dioxide

18 Why is the yellow colour of an aqueous solution of iron(III) chloride discharged when zinc dust is added?

1 $Fe^{3+}(aq) + 3e^- \rightarrow Fe(c)$
2 zinc chloride is formed in solution
3 zinc chloride is colourless

19 Which of the following are physical properties of pure iron?

1 white in colour
2 malleable
3 ductile

20 Which of the following can be used to prepare chlorine from moderately concentrated hydrochloric acid?

1 manganese(IV) oxide
2 potassium permanganate
3 potassium dichromate

21 Which of the following will evolve a colourless gas, which will decolourize aqueous potassium permanganate and leave a red-brown residue when heated strongly?

A iron(III) sulphate
B iron(II) carbonate
C iron(II) nitrate
D iron(II) sulphate
E iron(III) chloride

22 In which of the following reactions is sulphur dioxide the oxidizing agent?

A $2SO_2(g) + O_2(g) \rightarrow 2SO_3(g)$
B $H_2O(l) + SO_2(g) \rightarrow H_2SO_3(aq)$
C $2Mg(c) + SO_2(g) \rightarrow 2MgO(c) + S(c)$
D $SO_2(g) + 2HNO_3(aq) \rightarrow H_2SO_4(aq) + 2NO_2(g)$
E $NaOH(aq) + SO_2(g) \rightarrow NaHSO_3(aq)$

23 Which of the following elements will combine directly with chlorine to form a chloride which may be purified by sublimation?

A sodium **B** lead **C** calcium
D magnesium **E** iron

24 Which of the following reactions take place when chlorine bleaches a dye?

1 $Cl_2(g) + H_2O(l) \leftrightharpoons HCl(aq) + HClO(aq)$
2 $2HClO(aq) \rightarrow 2HCl(aq) + O_2(g)$
3 dye + $O_2(g) \rightarrow$ bleached dye

	ASSERTION		REASON
25	Iodine is a solid at room temperature	because	iodine may be purified by sublimation.

CHEMISTRY IN SOCIETY, INORGANIC

Questions 1 to 5

These questions refer to the list of elements set out below. Select the response which you think is the correct answer to the question.

A sodium **B** iron **C** carbon
D mercury **E** copper

1 Which is obtained from a salt on the industrial scale by means of cathodic reduction?

2 Which is used as a cathode in the manufacture of a solution of sodium hydroxide?

3 Which is extracted from a sulphide ore and then purified by an electrolytic method?

4 Which is extracted by reduction of its oxide with carbon monoxide and carbon?

5 Which is used in a very hard and pure form, not an alloy, for fitting to the tips of certain drills and cutting devices?

6 Why is it possible to obtain bromine from sea water by treating the sea water with chlorine?

A sea water is the only large source of bromine
B bromine is a liquid and chlorine is a gas
C chlorine is more electronegative than bromine
D chlorine is an oxidizing agent
E bromine is only sparingly soluble in water

7 *All* of the following require limestone ($CaCO_3$) for their production *except:*

A glass **B** cement **C** quicklime
D (pig)iron **E** paper

8 What does the term 'anodize' mean when applied to aluminium?

A the element is used as an electrode
B the thickness of the oxide layer is increased

C the manufacture of an aluminium alloy
D the use of aluminium paint to coat reflecting surfaces
E the depositing of the metal at the cathode during electrolysis

	ASSERTION		REASON
9	Zinc is extracted by electrolysis of the fused chloride	because	zinc chloride is hydrolysed in aqueous solution.
10	Sodium hydrogen carbonate is used as a remedy for indigestion	because	$HCO_3^-(aq) + H^+(aq) \rightarrow H_2O(l) + CO_2(g)$
11	Ammonium sulphate is used as a fertiliser	because	the ammonia will neutralize acids present in the soil.
12	The reaction: $C(c) + H_2O(g) \rightarrow CO(g) + H_2(g)$, is endothermic	because	the reaction: $2C(c) + O_2(g) \rightarrow 2CO(g)$, is exothermic.
13	Coke is a smokeless fuel	because	coke is obtained by the destructive distillation of coal.
14	Soap is a calcium salt	because	hard water forms a precipitate on the addition of soap.

15 Why is water gas used as a fuel?

1 a product of combustion of the gas is carbon dioxide
2 the combustion of water gas is exothermic
3 both carbon monoxide and hydrogen are inflammable

16 Which of the following will increase the yield of ammonia from the reaction between nitrogen and hydrogen?

1 increased pressure **2** increased temperature
3 use of a catalyst

17 Why are the silver halides used in photography?

1 the salts are photosensitive
2 the developer reduces the exposed salts to silver
3 unchanged silver halides are soluble in sodium thiosulphate

18 For which of the following is chlorine used?

1 sterilization of water supplies
2 manufacture of bleaching agents
3 manufacture of hydrogen chloride

19 In which of the following is sulphuric acid used?

1 the manufacture of fertilizers
2 the manufacture of detergents
3 as an electrolyte for secondary cells

20 Which of the following are relevant to the reaction represented by the equation:

$$CO(g) + H_2O(g) \leftrightharpoons CO_2(g) + H_2(g)$$

1 the forward reaction is exothermic
2 increased volume of steam will increase the yield of hydrogen
3 change of pressure will change the equilibrium mixture

21 Why are magnesium rods sometimes placed in the ground in contact with iron pipes?

A damp soil is an electrolyte
B iron corrodes in the presence of air and water
C magnesium forms the anode of a simple cell
D the magnesium forms an alloy with the iron
E magnesium is more electropositive than iron and dissolves in preference to the iron

22 Which of the following is used as a coolant in domestic refrigerators?

A carbon dioxide
B nitrogen
C chlorine
D sulphur dioxide
E ammonia

23 Which of the following reactions is catalysed by platinum gauze on an industrial scale?

A $2SO_2(g) + O_2(g) \rightarrow 2SO_3(g); \ -\Delta H$
B $2NO(g) + O_2(g) \leftrightharpoons 2NO_2(g)$
C $4NH_3(g) + 5O_2(g) \rightarrow 4NO(g) + 6H_2O(g); \ -\Delta H$
D $2NH_3(g) + H_2SO_4(aq) \rightarrow (NH_4)_2SO_4(aq); \ -\Delta H$
E $H_2(g) + Cl_2(g) \rightarrow 2HCl(g); \ -\Delta H$

24 In the manufacture of which of the following are ammonia, brine and limestone necessary?

A detergents
B fertilizers
C solid sodium hydroxide
D sodium carbonate
E water softeners

25 Which of the following reactions occur in the blast furnace when iron is extracted from its ore?

1 $CO_2(g) + C(g) \rightarrow 2CO(g); \ -\Delta H$
2 $CaCO_3(c) \leftrightharpoons CaO(c) + CO_2(g)$
3 $Fe_2O_3(c) + 3CO(g) \rightarrow 2Fe + 3CO_2; \ -\Delta H$

BASIC ORGANIC CHEMISTRY

1 Which of the following reagents are used to prepare methane in the laboratory?

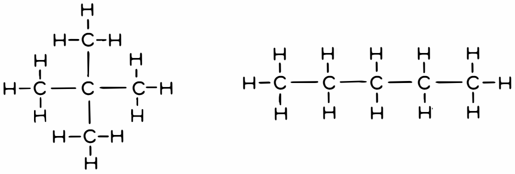
A sodium oxalate, sodium hydroxide
B sodium formate, concentrated sulphuric acid
C sodium acetate, sodium hydroxide
D sodium, ethanol
E carbon, steam

2 Why is methane used as a fuel?

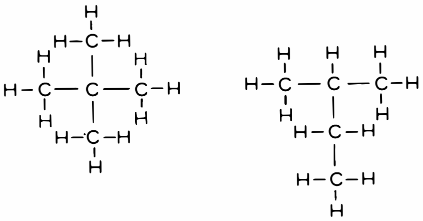
A 1 mole of methane contains 4 gram-atoms of hydrogen
B the products of combustion are carbon dioxide and water
C methane is a colourless, odourless gas
D methane forms a homogeneous mixture with air
E the combustion of methane is strongly exothermic

3 Which of the pairs of structural formulae set out below are *not* isomeric?

A



B



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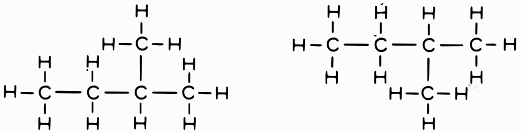
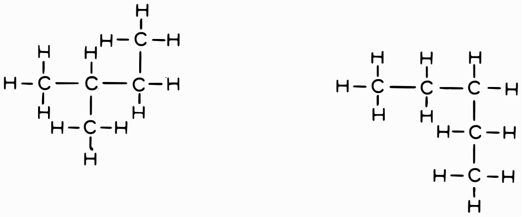
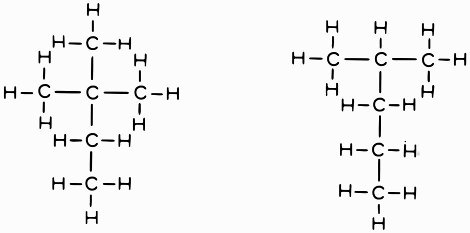


D



E



4 Which of the following crude oil distillates is used as a fuel for jet propelled aircraft?

A gas **B** petrol **C** kerosene
D light gas oil **E** heavy gas oil

5 Which of the following can be purified in the laboratory by fractional crystallization?

A naphthalene **B** propane
C starch **D** coal tar
E tetrachloromethane

6 Which of the following is a *principal* product of the destructive distillation of coal?

A diesel oil **B** paraffin wax
C carbon monoxide **D** hydrogen
E naphthalene

7 Why is acidified potassium permanganate unaffected by methane?

A the hydrogen atoms are joined to the carbon atom by single (covalent) bonds
B potassium permanganate is not an organic compound
C methane is insoluble in aqueous or acidic solutions
D the oxidation products of methane are carbon dioxide and water
E methane is an electron acceptor

8 Which of the following is an example of the preparation of a hydrocarbon by a *dehydration* process?

A pass ethanol vapour over heated alumina
B pass ethene (ethylene) and hydrogen over nickel
C heat crude oil and pass vapour over pumice stone
D pass methane and oxygen over nickel
E heat ethene, at high pressure, with oxygen as a catalyst

	ASSERTION		**REASON**
9	The reaction between chlorine and methane is an addition reaction	because	hydrogen chloride is one of the products formed.
10	Ethene will decolourize bromine water	because	ethene is an unsaturated hydrocarbon.
11	The valency (combining power) of carbon is 4 and of hydrogen 1	because	the general formula for paraffins (alkanes) is C_nH_{4n}.
12	Butane is used as a fuel	because	butane consists of carbon and hydrogen only.
13	The empirical formula of ethane is (CH_3)	because	the molecular formula of ethane is C_3H_9.
14	Isomers of a compound have the same chemical and physical properties	because	the position of atoms in a compound does not influence the properties of the compound.

15 Which of the following occur when sodium is added to an alcohol?

1 heat is evolved **2** effervescence occurs
3 hydrogen is evolved

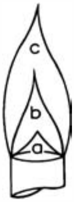
16 Which of the following are necessary for esterification to occur?

1 an alcohol **2** an organic acid
3 a dehydrating agent

17 A small quantity of phosphorus pentachloride was added to an organic liquid in a test tube. An exothermic reaction took place and a gas was evolved which gave white fumes with ammonia. Which of the following are correct?

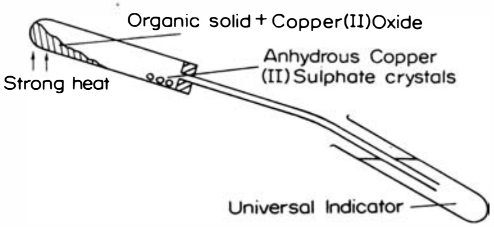
1 the gas evolved was hydrogen chloride
2 the liquid contained a hydroxyl group
3 the liquid consisted of carbon, hydrogen and oxygen only

18 Which of the following correctly describes a bunsen flame burning with maximum air supply?



1 (a) consists of air only
2 (b) is the hottest region of the flame
3 (c) is the region where combustion becomes complete

19


Organic solid + Copper(II)Oxide
Strong heat
Anhydrous Copper (II) Sulphate crystals
Universal Indicator

A sample of an organic solid was heated with copper (II) oxide. The apparatus was as shown in the diagram. If the organic compound was a reducing agent consisting of carbon and hydrogen only which of the following would you have expected to occur?

1 copper(II) oxide turned red
2 copper(II) sulphate turned blue
3 universal indicator changed colour

20 Why does a red-hot spiral of platinum wire continue to glow when placed just above the surface of methanol?

1 the oxidation of methanol is exothermic
2 platinum catalyses the oxidation
3 water is produced during the reaction

21 *All* of the following apply to the higher members of the alkanes *except:*

A burn readily in oxygen
B undergo chlorination
C exhibit isomerism
D may be cracked by heat alone at high temperatures
E liquids at room temperature which will not float on water

22 Which of the following occurs when a small quantity of red-hot copper(II) oxide is added to excess alcohol?

A carbon dioxide is evolved
B an unsaturated hydrocarbon is formed
C a copper(II) salt is formed
D copper(II) oxide is reduced to the metal
E the alcohol is dehydrogenated

23 Which of the following can be used to dry an alcohol?

A concentrated sulphuric acid
B phosphorus pentoxide
C calcium chloride
D calcium oxide
E alumina

24 Which of the following reaction types occurs when aqueous silver nitrate is added to an alkyl halide (e.g. monochloroethane)?

A addition **B** hydrolysis
C polymerization **D** nitration
E neutralization

	ASSERTION		**REASON**
25	Ethanol is obtained by the fermentation of glucose	because	enzymes convert glucose to ethanol and carbon dioxide.

POLYMERS, PROTEINS and MACROMOLECULES

Questions 1 to 5
These questions refer to the list set out below. Select the response which you think is the correct answer to the question.

A	starch	**B**	cellulose	**C**	polyethylene
D	styrene	**E**	graphite		

1 Which consists of one element only?

2 Which turns blue when in contact with 'free' iodine?

3 Which is obtained by chemically combining a large number of simple molecules?

4 Which is obtained as a liquid by distilling a macromolecule at a temperature below 1 200 K?

5 Which forms part of the cell walls of plants?

6 Which of the following is a compound of carbon and hydrogen only?

A glucose
B starch
C cellulose
D polypropylene
E DNA (a complex organic acid)

7 Which of the following compounds will react with an organic acid to give a compound known as a fat?

A	glycerol	**B**	ethanol
C	ethene	**D**	formaldehyde
E	glucose		

8 A sample of an organic compound was warmed with a dilute mineral acid, Fehlings solution was then added and the resulting mixture was again warmed and on warming a red deposit formed. Which of the following was the organic compound?

A	nylon	**B**	starch
C	polyvinyl chloride	**D**	glycerol
E	ethane-1, 2-diol		

	ASSERTION		REASON
9	A sugar is composed of hydrated carbon atoms	because	concentrated sulphuric acid removes water from a sugar and leaves a residue of pure carbon.
10	Human skin contains protein	because	moderately concentrated nitric acid will turn skin yellow.
11	Fats are soluble in water	because	milk is a solution of a fat in water.
12	Soap is a sodium salt of a fatty acid	because	soap is soluble in water.
13	Proteins are sensitive to heat	because	the white of egg changes its physical characteristics when heated.
14	X-rays have no effect on proteins	because	X-rays are not absorbed by the body.

15 What happens when powdered starch or lycopodium powder is blown into a bunsen flame?

1 a large quantity of energy is released
2 carbon dioxide is produced
3 a non-luminous flame is observed

16 A sample of starch was treated with saliva and then subjected to tests. Which of the following results would be obtained?

1 a blue colour with iodine
2 a yellow colour with moderately concentrated nitric acid
3 a red colour with Fehlings solution

17 Which of the following is characteristic of sugars?

1 insoluble in water
2 crystalline solids
3 general formula: $C_nH_{2m}O_m$

18 What will happen if an isocyanate, a polyether, a blowing agent and a catalyst are mixed?

1 heat energy will be evolved
2 poisonous fumes will be evolved
3 an expanded plastic will be produced

19 Which of the following are required to produce nylon in the school laboratory?

1 formalin
2 hexamethylene diamine
3 adipyl (or sebacoyl) chloride

20 Why is starch said to be a macromolecule?

1 has a very large molecular weight
2 insoluble in water
3 no apparent crystalline structure

21 Which of the following may be obtained from milk?

A casein **B** Perspex **C** Terylene
D styrene **E** cellulose

22 Which of the following consists of protein molecules?

A nylon **B** wool
C Cellophane **D** margarine
E phenol formaldehyde

23 Which of the following elementary tests is used in the school laboratory to distinguish between different types of plastics?

A elasticity
B colour
C density
D chromatography
E colour of flame when burned in air

24 Which of the following will affect nylon?

A alcohol **B** ammonia
C bleaching powder **D** tetrachloromethane
E dilute nitric acid

	ASSERTION		**REASON**
25	Butter is an unsaturated fat	because	melted butter will decolourize bromine water.

CHEMISTRY IN SOCIETY, ORGANIC

1 What is meant by the term ‘cracking’ in the petroleum industry?

A the removal of hydrogen from a compound
B preparing a polymer from a monomer
C breaking a —C—C— bond by the action of heat
D obtaining light fractions from crude oil
E the addition of antiknock compounds to petrol

2 Why is it possible to remove grease from clothes by using a detergent?

A detergents are very soluble in water
B a detergent is a synthetic soap
C water with detergent added will ‘wet’ cloth
D detergents combine with grease to form an emulsion
E a detergent is derived from a ‘higher’ paraffin

3 Which of the following is *not* synthetic?

A silk **B** Acrilan
C polyurethane **D** Terylene
E neoprene

4 Which of the following applies only to a thermosetting plastic?

A produced by the action of heat and pressure
B increases in flexibility with increased temperature
C can be softened only once during moulding
D produced by polymerization of unsaturated hydrocarbons
E melts to a viscous liquid on heating

5 Why is a fuel of a high octane rating recommended for a high performance internal combustion engine?

A low octane petrol has a high boiling point
B to produce a uniform flame under load
C high octane fuel is easily vapourized
D no carbon deposit is formed during combustion
E high octane fuel has a low lead content

6 Plastics are made by direct combination, or polymerization of *all* of the following *except:*

A formaldehyde
B ethene
C propene
D ethane-1,2-diol(ethylene glycol)
E butane

7 Which of the following is most suitable for, and is used most for, thermal insulation?

A Bakelite
B high density polythene
C polyvinylchloride
D expanded polystyrene
E Perspex

8 Which of the following is manufactured by a fermentation process?

A ethanol **B** methanol **C** soap
D margarine **E** detergents

	ASSERTION		**REASON**
9	A diesel engine does not have 'spark' plugs	because	a large amount of heat is evolved when the fuel-air mixture is compressed.
10	A fat is not a carbohydrate	because	fats are not a source of energy.
11	Sea water does not contain dissolved salts	because	a detergent will not give a precipitate with sea water.
12	Bitumen is used for road construction	because	the bitumen molecule contains a large number of carbon atoms.
13	Naphthalene is a product of the destructive distillation of coal	because	naphthalene is a crystalline hydrocarbon.

14 Polyethylene is destroyed by atmospheric oxidation because the oxidation products of compounds containing carbon and hydrogen only are carbon dioxide and water.

15 Why are some plastics classified as ‘rubbers’?

1 the molecular chains have different lengths
2 the inter-molecular forces are weak
3 when stretched the fibres get closer together

16 What is meant by the statement that ‘polyethylene is a thermosoftening plastic’?

1 its molecules gain energy when the temperature is raised
2 the molecular chains become closer together after heating and then cooling
3 the polymer can be softened and reformed indefinitely

17 Which of the following are necessary requirements of a fuel which is to be used for aero-engines?

1 low freezing point **2** low viscosity
3 high volatility

18 Why is ethane-1,2-diol(ethylene glycol) suitable for use as an ‘anti-freeze’ for water cooled engines?

1 miscible with water
2 ethane-1,2-diol is an alcohol
3 an ethane-1,2-diol and water mixture freezes at a temperature lower than that normally experienced during winter

19 Why is PVC (polyvinylchloride) used to cover electric cables?

1 opaque **2** flexible **3** waterproof

20 Why do mountaineers often carry glucose tablets instead of bread?

1 bread contains starch
2 glucose is a source of energy
3 glucose requires no digestion

Questions 21 to 25

These questions refer to the list given below. Select the response which you think is the correct answer to the question.

A	cotton	**B**	detergent
C	polyurethane foam	**D**	phenol formaldehyde
E	Perspex		

21 Which is light, hard, transparent and brittle?

22 Which is obtained as a result of a strongly exothermic reaction in which a large volume of carbon dioxide is evolved?

23 Which does not have a macromolecular structure?

24 Which will cause a neutral solution of universal indicator to change colour?

25 Which has the same empirical formula as starch?

PHYSICAL and MATHEMATICAL CHEMISTRY I

1 *All* of the following equations are balanced *except:*

A $2H_2O_2 \rightarrow 2H_2O + O_2$
B $Ca(OH)_2 + 2HCl \rightarrow CaCl_2 + 2H_2O$
C $Pb(NO_3)_2 \rightarrow PbO + 2NO_2 + O_2$
D $Fe_2(SO_4)_3 \rightarrow Fe_2O_3 + 3SO_3$
E $Cu + 4HNO_3 \rightarrow Cu(NO_3)_2 + 2H_2O + 2NO_2$

2 In which of the following does a metal exhibit a valency (combining power) of 7?

A $Pb^{++} . [CrO_4]^{--}$
B $2K^+ . [Cr_2O_7]^{--}$
C $2Na^+ . [ZnO_2]^{--}$
D $Na^+ . [MnO_4]^-$
E $4K^+ . [Fe(CN)_6]^{4-}$

3 How many grams of bromine will be displaced from an aqueous solution of a bromide by 0·2 moles of chlorine?

A 2·0
B 16
C 32
D 71
E 142

4 How many gram-atoms of lead will have the same number of atoms as 64 grams of oxygen?

A 64/32
B 64/16
C 208/64
D 208/16
E 64/1

5 When 0·24 gram of a metal completely combined with oxygen, 0·4 gram of a solid residue was obtained. What mass of the same metal will combine with 2 gram-atoms of oxygen?

A 0·12
B 0·16
C 1·20
D 24·0
E 48·0

6 What mass, in grams, of copper(II) sulphate must be dissolved in 0·5 cubic decimetre of deionized water to produce a 5 M solution?

A $160/5$
B 160×5
C $160 \times 2 \times 5$
D $(160 \times 5)/2$
E $(160 \times 2)/5$

7 How many cm^3 of 0·1 M hydrochloric acid would have

to be added to 25 cm^3 of 0·2 M sodium carbonate for complete neutralization?

A 10·0 **B** 12·5 **C** 25·0
D 50·0 **E** 100·0

8 How many cm^3 of hydrogen would be evolved when an excess of magnesium is added to 10 cm^3 of 2 M hydrochloric acid at STP?

A 20·0 **B** 224 **C** 448
D 22 400 **E** 44 800

	ASSERTION		**REASON**
9	When sodium chloride is added to water a chemical change occurs	because	sodium chloride is separated from water by fractional distillation
10	Ink contains several compounds	because	ink can be separated into its components by chromatography.
11	The rate of diffusion of a gas is dependent upon the density of the gas	because	hydrogen diffuses more rapidly than carbon dioxide under the same conditions.
12	When concentrated sulphuric acid is diluted it is partially neutralized	because	heat is evolved when the acid is added to water.
13	The e.m.f. of a cell with copper and zinc electrodes is greater than that of a copper and magnesium electrode cell for the same electrolyte	because	magnesium will displace copper from a solution of its salts and hydrogen from steam.
14	The solubility of all salts is directly proportional to the temperature of the solvent	because	more sodium nitrate dissolves near the steam point than at room temperature.

15 What can be deduced from the equation:

$$H_2O_2(aq) + 2H^+(aq) + 2e^- \rightarrow 2H_2O(l)$$

1 hydrogen peroxide is a reducing agent
2 the reaction takes place in acid solution
3 2 faradays of charge are transferred per mole of hydrogen peroxide

16 Hydrogen was passed over heated copper(II) oxide and all the gaseous products were passed through previously dried calcium chloride. The calcium chloride gained weight because water was a product of the reaction. What additional information would be required to determine the formula of water?

1 the mass of water formed
2 the mass of oxygen lost from the copper(II) oxide
3 the mass of copper residue

17 A liquid was heated by a 10 watt immersion heater for 100 seconds at 78 °C. No rise in temperature of the liquid occurred although a loss in mass was noted. Which of the following conclusions can be drawn?

1 the liquid has a higher vapour pressure than water at 78 °C
2 the boiling point of the liquid is 78 °C
3 1 000 joules of heat energy were supplied to the liquid

18 Which of the following occurs when a small quantity of sodium dissolves completely in water at room temperature?

1 ionization **2** increase in pH
3 physical change

19 Why is heat *evolved* when zinc powder is added to copper(II) sulphate solution?

1 zinc requires less energy than copper to ionize
2 zinc powder has a large surface area
3 zinc and copper can be used as electrodes for a simple cell

20 Which of the following are required to determine the volume of one atom of an element?

1 Avogadro's number

2 mass of 1 gram-atom of the element
3 density of the element

21 If the formula of a hydrocarbon is C_xH_y how many gram-atoms of oxygen will be required for its *complete* combustion?

A $x + y/4$ **B** $x + y/2$ **C** $x + y$
D $2x + y/2$ **E** $2x + y$

22 Which of the following will yield a precipitate equivalent to 1/400 of a mole of precipitant?

A 25 cm³ of 0·1 M sulphuric acid and excess aqueous lead(II) nitrate
B 50 cm³ of 0·2 M barium chloride and excess 0·1 M sulphuric acid
C 25 cm³ of 1·0 M lead(II) nitrate and 25 cm³ of 1·0 M hydrochloric acid
D 1 cm³ of 0·1 M magnesium sulphate and 25 cm³ of 10 M sodium carbonate
E 25 cm³ of 0·2 M silver nitrate and excess 0·1 M hydrochloric acid

23 How many cubic decimetres of oxygen would be evolved at a pressure of 2 atmospheres and a temperature of 273 K when 2 moles of hydrogen peroxide are catalytically decomposed?

A 5·6 **B** 11·2 **C** 22·4
D 44·8 **E** 89·6

24 The density of an oxide of nitrogen is 22 times larger than that of hydrogen and one volume of the oxide leaves one volume of nitrogen on decomposition. What is the formula of the oxide?

A N_2O **B** NO **C** N_2O_4
D N_2O_3 **E** N_2O_5

25 Which of the following equations is *not* in agreement with the Law of Conservation of Mass?

A $2C_2H_5OH(l) + 2Na(c) \rightarrow 2C_2H_5ONa(c) + H_2(g)$
B $CaCl_2(aq) + H_2C_2O_4(aq) \rightarrow CaC_2O_4(c) + 2HCl(aq)$
C $2Ba(NO_3)_2(c) \rightarrow 2BaO(c) + 2NO_2(g) + O_2(g)$
D $Cu^{++}(aq) + 4NH_3(l) \rightarrow [Cu(NH_3)_4]^{++}(aq)$
E $Cu(c) + O_2(g) + 2H_2SO_4(aq) \rightarrow CuSO_4(aq) + 2H_2O(l)$

PHYSICAL and MATHEMATICAL CHEMISTRY II

Questions 1 to 5

These questions refer to the radioactive decay chain set out below. Select the response which you think is the correct answer to the question.

$$ {}^{238}_{92}\mathbf{A} \xrightarrow{\mathbf{B}} {}^{234}_{90}\mathbf{C} \xrightarrow{\mathbf{D}} {}^{234}_{91}\mathbf{E} $$

1 Which is equivalent to the nucleus of a helium atom?

2 Which is emitted when a proton is gained by the nucleus and energy is lost from the nucleus?

3 Which has the largest mass number?

4 Which has an atomic number equal to zero?

5 Which has the largest number of neutrons?

6 What is the formula weight, in grams, of anhydrous copper(II) nitrate?

A 62 **B** 78 **C** 94
D 126 **E** 188

7 How many grams of copper will be deposited from an aqueous solution of copper(II) sulphate using copper electrodes when 10 coulombs of electricity are passed?

A $32 \times 10 \times 96\,000$ **B** $(32/10) \times 96\,000$
C $32/(10 \times 96\,000)$ **D** $(32 \times 10)/96\,000$
E $(10 \times 96\,000)/32$

8 What is the solubility of a salt at 40 °C if 15 grams of the solute dissolve in 24 grams of water at that temperature and 1 atmosphere pressure?

A $(24 \times 100)/15$ **B** $24/(15 \times 40)$
C $(15 \times 100)/24$ **D** $(15 \times 100)/(24 \times 40)$
E $15/24$

	ASSERTION		**REASON**
9	Fission occurs when uranium is bombarded by neutrons	because	the neutrons are absorbed into the uranium nucleus.

10 The volumes of gases which react and the volumes of the products, if gaseous, are in a simple numerical ratio if measured under the same physical conditions because $N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g)$.

11 1 mole of hydrogen is equal in mass to 1 mole of oxygen at STP because equal volumes of all gases at the same temperature and pressure contain equal numbers of molecules.

12 Concentrated hydrochloric acid has the same effect upon the decomposition of aqueous sodium thiosulphate as the same volume of dilute hydrochloric acid because the rate at which a chemical reaction proceeds is independant of the concentration of the reactants.

13 The reaction: $N_2(g) + O_2(g) \rightleftharpoons 2NO(g); + \Delta H$, is carried out at a high temperature because the equilibrium position changes to oppose any external applied effect.

14 The heat of combustion, $\Delta H_c^\theta(298K)$ of methane is less than that of butane because a molecule of butane is larger than a molecule of methane.

15 Why must external energy be supplied to convert water into steam at its boiling point?

1 steam is hotter than water at the steam point
2 steam has a lower density than water
3 work must be done to separate the molecules of water from each other

16 What energy is possessed by a solid chemical compound at room temperature?

1 bonding energy between the atoms

2 kinetic energy of the molecules
3 electrostatic energy between the electrons and protons of individual atoms

17 Which of the following is characteristic of a radioactive isotope?

1 affect photographic plates
2 emit radiations randomly
3 the intensity of the radiations will increase with time

18 Which of the following is a property of α-radiation?

1 produces ionization of the air
2 absorbed by thick card
3 not deflected by strong magnetic fields

19 A coin is placed on top of an unexposed photographic plate in a darkroom, and a radioactive source is fixed in position above the plate and left for 48 hours. Why does a 'shadow' of the coin appear on the plate when the plate is developed?

1 the coin absorbs some of the radiation
2 the source emits γ-radiation only
3 the coin is made of lead

20 Why is it possible to obtain electrical energy from the reaction:

$$Zn(c) + Cu^{++}(aq) \rightarrow Zn^{++}(aq) + Cu(c)$$

1 the standard heat of formation of crystalline zinc is zero
2 the e.m.f. of the cell is 1·10 volt
3 2 faradays of charge are transferred per gram equation

21 Heat is supplied at a steady rate to a solid (Q joules per minute) and m grams of solid were converted to the liquid state in t minutes. How much heat, in joules, would be required to convert 1 mole of the solid, which has a mass of M grams, into a liquid at the same temperature?

A $(Q \times t \times m)/M$ **B** $(Q \times t \times M)/m$
C $(t \times M)/(Q \times m)$ **D** $(Q \times M)/(t \times m)$
E $Q \times t \times m \times M$

22 Which of the following will raise the boiling point of a liquid?

A decreased pressure
B increased temperature
C addition of a solute
D decreased surface area
E increased thermal insulation of the container

23 Which of the following can be added to water at room temperature in order to *lower* the temperature of the water?

A magnesium sulphate
B ammonium nitrate
C potassium hydroxide
D hydrogen chloride
E sulphur dioxide

	ASSERTION		**REASON**
24	The total pressure exerted by a mixture of non-reacting gases is the sum of the partial pressures of each gas	because	when hydrogen is collected over water the vapour pressure of the water must be added to the pressure of the 'wet' hydrogen to determine the pressure exerted by the hydrogen alone.
25	A compound consists of molecules and each molecule consists of the the same number and types of atoms	because	all samples of copper(II) oxide are chemically identical irrespective of method of production, and the ratio of the mass of copper to the mass of oxygen in any sample is a constant.

1 Five-choice completion

These are items which are followed by five responses and you must select the response which is thought to be correct.

2 Multiple selection

Response	Correct statements
A	**1,2,3**
B	**1,2**
C	**2,3**
D	**1**
E	**3**

3 Assertion—reason

Response	Assertion	Reason	Explanation
A	true	true	reason is a correct explanation of assertion
B	true	true	reason is *not* a correct explanation of assertion
C	true	false	
D	false	true	
E	false	false	